Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL and E. S. GREW, M.A.

VOL. II. No. 2. [NEW SERIES.] FEBRUARY, 1905. [Entered at Stationers' Hall.] SIXPENCE.

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Editorial.

AT the end of the first year of the New Series of "KNOWLEDGE," it will not, perhaps, appear supererogatory to review the progress of the journal since its amalgamation with the "ILLUSTRATED SCIENTIFIC NEWS," from a material as well as from an editorial standpoint. It was intended in the amalgamation to preserve and present the features of both periodicals; that is to say, while the editors were determined that there should be no falling off either in the amount or the value of those contributions to Astronomic and Natural Science which had, up to that time, formed the chief contents of "KNOWLEDGE," they also believed that it was desirable to effect a general re-arrangement of the periodical, and to add to it articles on Physics, Chemistry, and Applied Science. The reason for this belief was not alone that they thought themselves bound to such a programme out of consideration for the large number of readers of the "ILLUSTRATED SCIENTIFIC NEWS" who had become subscribers to the amalgamated periodical; but because they were convinced that in the new significance and importance which applied science is now recognised as having in every department of the national life, there was a real demand for an organ which should deal with such subjects in a manner that was at once authoritative, comprehensible, and interesting. No pains or expense were therefore spared to attain this end, and it is an ideal to which the conductors of the paper will steadily adhere during the coming year. The difficulties that have presented themselves are none the less considerable. In the first place there has been the question of preserving the former scientific interests of the paper without diminution, while adding the new subjects. That has been a matter which has involved considerable additional expense, because it has necessitated not only the payment for special articles, but the enlargement of the paper by the double method of increasing the number of its pages and of adding to the quantity of contributed matter by the reduction, on several pages, of the type. We believe that in spite of one or two complaints that this or that subject has been included which an isolated reader did not want, the endeavour has completely succeeded, and that we have added alike to the attractiveness and value of "KNOWLEDGE." The feature of attractiveness has also involved better printing, a very large increase in the number and variety of illustrations, and a better quality of paper. These matters have been among the additional sources of expense, and in order that the standard which has been set up may be maintained, we desire to make a special appeal to readers of "KNOWLEDGE AND THE SCIENTIFIC NEWS" to give us an increasing support. There is no other scientific periodical in the United Kingdom which occupies the same or even a similar position, and in making this appeal we feel that we are doing so not only on behalf of the commercial success of our venture, but on behalf of the popular advancement of scientific teaching and information.

Some of the commercial difficulties that we have encountered in an anxious year have made it necessary to effect a re-arrangement of the editorial staff, but during the coming year the journal will be conducted by the same editors as heretofore, with the exception that Mr. E. Walter Maunder, F.R.A.S., in whose hands the Astronomical editorship of "KNOWLEDGE" has been so long, and whose services to the paper have been most valuable, will, we regret to say, no longer be able to continue in that position. We hope, nevertheless, that his name will continue to appear as a contributor to the paper. Steps are being taken to place the astronomical editorship in responsible hands, and articles on astronomical subjects will continue to appear from Miss Agnes Clerke, Dr. W. J. S. Lockyer, Mr. J. E. Gore, and Mr. Shackleton.

In addition to some fine astronomical photographs which we hope to present as full-page supplements, we are having prepared some star maps on a new and original system, which, when collected, should form a complete atlas of the heavens.

It is proposed to continue the articles on Physics, Chemistry, and Geology, which have been a feature of the later numbers, and we have been promised a continuance of contributions by Prof. A. W. Porter, Dr. F. Mollwo Perkin, Prof. Grenville Cole, and Mr. H. J. H. Fenton. Natural History will again be expounded by such authorities as Dr. Sclater, Mr. Lydekker, Mr. P. Collins, and others. In all other respects "KNOWLEDGE" will be conducted on those lines which in the past year we hope have proved to be acceptable to the great majority of our readers.

XUM

Modern Cosmogonies.

XII.—Our Own System.

By MISS AGNES M. CLERKE.

OUR sun is clearly middle-aged. It bears none of the marks associated with juvenility in stars; and its decrepitude is in the distant future. It is crossing, probably, a level tract where recuperation so nearly balances expenditure that radiation can be maintained for an indefinite time at a high and fairly uniform standard. Stars of the solar type pursue the even tenour of their way with particularly few interruptions They show little tendency to intrinsic variability. Their periodicity, when it exists, is due to the presence of a companion. Light-changes can thus be impressed upon them by external influence; they do not conspicuously arise through native instability.

Our planet, accordingly, is attached to a safe and steady luminary; one subject, not to destructive spasms, but to vicissitudes so mild as to evade distinct meteorological recognition. It is, moreover, governed by a polity settled on a broad basis of tranquillity and permanence. All this is as it should be. The conditions specified were a pre-requisite to the unfolding of human destinies. Nor can it be confidently asserted that they have been realised anywhere else. Our system may be unique; while, on the other hand, replicas of it might, imperceptibly to us, be profusely scattered through the wide realms of space. It is certain that a telescopic observer on Sirius or α Centauri would see our sun unattended; not even Jupiter could be brought into view by optical appliances in any degree comparable to those at our disposal. There are, nevertheless, strict limitations to the possible diffusion of planetary worlds like those that wander amid the zodiacal constellations. We have become aware of incapacitating circumstances, by which a multitude of stars are precluded from maintaining retinues of subordinate globes. Spectroscopic discoveries have compelled a revision of ideas as to cosmical arrangements. Especially the large proportion established by them of binary to single stars makes it impossible any longer to regard the solar system as a pattern copied at large throughout the sidereal domain. We cannot, then, compare it with any other; the mechanism of which the earth forms part must, perforce, be studied in itself, and by itself; and it may, for aught that appears, be the outcome of special and peculiar design.

The machine in question is self-sustaining and self-regulating; no extraneous influence noticeably affects its working. This exemption from disturbance is the fortunate consequence of its isolation. A great void surrounds it. The span of Neptune's orbit is but a hand-breadth compared with the tremendous unoccupied gulf outside—unoccupied, that is to say, by bodies of substantial mass. The feebleness of star-light relatively to sun-light affords some kind of measure of the impotence of stellar attractions to compete with the over-ruling gravitational power that sways the planetary circulation. This it is which gives to it such remarkable stability. The incomparable superiority of the sun over his dependant orbs not only safeguards them against foreign interference, but reduces to insignificance their mutual perturbations. Hence, the strong concentration of force exemplified in our system —the absolutely despotic nature of the authority exercised—makes for a settled order by excluding subversive change.

The organisation of the solar kingdom, as disclosed by modern research, is greatly more varied and complex than Laplace took it to be. His genetic scheme was, indeed, no sooner promulgated than deviations from the regularity and unanimity of movement upon which it was based began to assert their inconvenient reality. They have since multiplied; and, emerging to notice under the most unlikely aspects, they occasion incongruities which tax, for their explanation, all the resources and audacities of the most inventive cosmogonists. Let us briefly consider their nature.

The swarm of asteroids that bridge the gap between Mars and Jupiter revolve, it is true, with the general swirl of planetary movement; but use a large licence as regards the shape and lie of their orbits, and their partial exemption from the rules of the road becomes entire for comets and meteors, which have proved themselves, nevertheless, to be aboriginal in our system by their full participation in its proper motion. Finally, several of the major planets set convention at defiance in the arrangement of their several households, and thereby intimate departures from the supposed normal course of development so frequent and so considerable as to shake belief even in its qualified prevalence. Thus, the anomalously short period of Phobos, the inner satellite of Mars, besides throwing doubt over its own mode of origin, tends to obscure the history of its more sedately circulating associate. The sub-systems of Uranus and Neptune exhibit, moreover, eddies of retrograde movement, suggesting primitive disturbances of a fundamental kind; while the surprising disclosures connected with Saturn's first-born, and furthest satellite, have added one more knotted thread to the tangled skein we would fain unravel. Until acquaintance was made with Phœbe, counter-flows of revolution within the same satellite-family were unknown, and, if contemplated at all, would have been scouted as impossible. One ternary star, to be sure— ξ Scorpii—had been recognised as probably owning an immediate and a more remote attendant, in oppositely directed orbital movement; but the cases are in many ways disparate, and the analogy, though instructive, is imperfect.

If the ninth Saturnian moon is to be regarded as sprung from the mass of its primary, a total change in the condition of the parent body must have supervened during the long interval between its separation and that of its successor Iapetus. The change, in Professor W. H. Pickering's opinion,* was nothing less than a reversal in the sense of axial rotation. The nebulous spheroid destined to develop into the wonderful Saturnian system had a diameter, when Phœbe was thrown off from it, of sixteen million miles, and gyrated tranquilly from east to west, in a period of about a year and a half. The action of sun-raised tides, however, availed first to destroy, and finally to invert this movement; for the natural outcome of tidal friction is synchronism, and this implies agreement, both in period and direction, between the rotation and revolution of the body acted upon. Acceleration through contraction did the rest; and before Iapetus entered on its separate career, the originating globe span normally in seventy-nine days. The view that such was the course of events is plausible at first sight;

* *Harvard Annals*, Vol. LIII., p. 61, where, however, the reversal is explained by a shifting of the axis of rotation. The mode of action described in the text was long ago suggested by Kirkwood.

yet the doubt remains whether the cause alleged was adequate to the effect produced. At the distance of Saturn, solar tidal friction exerts only about one-twenty-thousandth its power on the earth *; its efficacy would, it is true, be greatly enhanced by the distension of the mass subjected to it; but approximately to what extent, it baffles our powers of calculation to determine.

The one certain inference derivable from the diversity of facts ascertained within the last hundred years is that our world is not (so to speak) machine-made. The *modus operandi* employed to disengage the planets from their nebulous matrix was not of cast-iron rigidity; it was adaptable to circumstances; it left room for the display of boundless inventiveness in details. This, nevertheless, was made to consist with the perfect preservation of the main order, both in design and operation. The general plan is broadly laid down and unmistakable, and the springs of the machine are undisturbed in their free play. And for the primary reason that departures from regularity, which might, in any way, prove a menace to stability, affect bodies of negligible mass. The great swing of settled movement goes on irrespectively of them. *De minimis non curat lex.* Thus, the erratic behaviour of comets is harmless only because of their insignificance. If pursued by substantially attractive masses, it could not fail to jeopardise the planetary adjustments. Even the asteroids would be unsafe neighbours but for their impotence; and it is remarkable that Mercury, by far the smallest of the major planets, circulates along a track of the asteroidal type. It would seem as if an important size carried with it an obligation to revolve in an orbit of small eccentricity, inclined at a low angle to the principal plane of the system. The reason why this should be so is not obvious; but were it otherwise, the equilibrium, now so firmly established, would subsist precariously, or not at all.

The assertion, indeed, that it is firmly established, can only be made under reserve. We are ignorant of any causes tending towards its overthrow; yet they may supervene, or be already subtly active. One such lurking possibility is the presence of a resisting medium in interplanetary space. Waifs and strays of matter must, at any rate, be encountered there—outlawed molecules, self-expelled from the gaseous envelopes of feeble globes; thin remnants of cometary paraphernalia, driven off amid the fugitive splendours of perihelion; products of ionic dissociation set flying by the impact of ultra-violet light—and all disseminated through an ethereal ocean, which "is cut away before, and closes from behind," as moving bodies traverse it. That its indifference is shared by ordinary material substances, when in the last stage of attenuation, is a plausible but unverified conjecture. It is only safe to say that retardation of velocity in what may pass for empty space is insensible, or null.

There may, nevertheless, be springs of decadence in the solar system. Some of them have been discussed by M. Poincaré,† whose confidence in the reassuring demonstrations of Laplace and Lagrange is inversely proportional to the magnitude of the terms they were forced to neglect. They dealt with fictitious globes, devoid of appreciable dimensions, and swayed by the strict Newtonian law. But the real planets and their satellites are acted on by other forces as well, frictional, magnetic, radio-repulsive; and their joint effects may not be wholly evanescent. The tidal drag on rotation undoubtedly occasions a small but irretrievable loss of energy. The moon, for instance, as M. Poincaré states, now gains, by the reactive consequences of tidal friction in widening its orbit, no more than $\frac{1}{28}$ the *vis viva* of which the earth is deprived by the infinitesimal slowing down of its rotation. And the remaining $\frac{27}{28}$ths, being dissipated abroad as heat, are finally abstracted from the system. The ultimate state, we are told, towards which the planetary mechanism tends, is that of the synchronous revolution, in a period of about twelve years, of all its members. This might, apart from a possibly resisting medium, have indefinite permanence; otherwise precipitation to the centre would gradually ensue, and one solitary sphere, cold, stark, and unilluminated, would replace the radiant orb of our cerulean skies, with its diversified and exquisitely poised *cortège*. Unsecured drafts upon futurity, however, are not among the most valuable assets of science; and a consummation so incalculably remote may be anticipated by a score of unforeseen contingencies. What can be, and has been ascertained, is the relative durability of the scheme with which the visible destinies of the human race are so closely connected. It will, beyond question, last long enough for their accomplishment. Curiosity that would seek to penetrate further is likely to remain ungratified.

But this is not all. There are other, and incalculable items in the account. The sun, although an autocrat within his own dominion, is himself subject to external influences. As a star, he is compelled to follow whithersoever the combined attractions of his fellow-stars draw him; nor can we thoroughly interpret the summons which he obeys. The immediate outcome in the transport of the solar system towards the constellation Lyra, has, it is true, been determined; but the eventual scope and purpose of the journey remain profoundly obscure. The pace is to be reckoned as leisurely; twelve miles a second is little more than half the average stellar speed. We should, however, probably suffer no inconvenience from being whirled through the ether in the train of such a stellar thunderbolt as Arcturus. Only the excessive velocities of any adventitious bodies we might happen to pick up would betray to ordinary experience the fact of our own swift progress. As it is, our sweepings from space appear to be scanty. If shreds from inchoate worlds, or dust of crumbled worlds, strewed the path of our system, they should be annexed by it in its passage, temporarily or completely; and we should then expect to find the apex of the sun's way marked, if no otherwise, by the predominant inflow from that quarter of comets and meteors. Yet there is no trace of such a preference in the distribution of their orbits. Hence the enforced conclusion that the sun has attached to him, besides the members of his immediate household, an indefinite crowd of distant retainers, which, by their attendance upon his march, claim with him original corporate unity. To this rule there may be a few exceptions. An occasional aërolite probably enters the earth's atmosphere with hyperbolic velocity, and takes rank accordingly as, in the strictest sense, a foreign intruder; but the broad truth can scarcely be challenged that the sun travels through a virtual void.

We can, however, see no necessity why he should for ever continue to do so. Widely different conditions seem to prevail near the centre, and out towards the circumference of the sidereal world. What may be designated the interior vacuity of the Milky Way is occupied mainly by stars of the solar type, including

* G. H. Darwin, *Phil. Trans.* Vol. CLXXII., p. 526; Moulton, *Astroph. Jour.*, Vol. XI., p. 110.

† *Annuaire du Bureau des Longitudes*, 1898

one to our apprehension super-eminent over the rest; they are separated by vast, apparently clear intervals; they are non-nebulous, and of stable constitution. This secure habitat is ours for the present; it may, nevertheless, at some future time be exchanged for one less exempt from disturbance. The shape and size of the sun's orbit are utterly unknown ; the changes of environment, accordingly, that will accompany the description of it defy conjecture. Our actual course is inclined at a small angle to the plane of the Milky Way. It will presumably become deflected; but perhaps not sufficiently to keep our system clear of entanglement with the galactic star-throngs. In our ignorance of their composition, no forecast of the results can be attempted; they are uncertain and exorbitantly remote. Moreover, the comparative slowness of the sun's motion in a manner guarantees the permanence of his subsisting cosmical relations. For anything that science can tell, they may ultimately be subverted by some preordained catastrophe; but the possibility lies outside the field of legitimate speculation.

The universe, as reflected in the mind of man, gains extent as the mirror acquires polish. Early astronomers conceived of but one solar system, and one "dædal earth," upon which the " pale populace of heaven " rained influences sinister or propitious. Later, human egotism took another form. The whole universe was assimilated to our particular little settlement in it. Terrestrial conditions were universalised. None divergent from them were counted admissible or profitable. But one answer seemed possible to the perpetual *Cui bono?* with which restless thought assailed the heavens. But one purpose was regarded as worthy of fulfilment; that of multiplying, in distant sidereal climes, copies of our own planet, and of providing suitable locations for myriads of intellectual beings, as little alien to ourselves as might be compatible with the minimum of diversity in their material surroundings.

The spread of this astral philanthropy has, nevertheless, been in some measure checked by the advance of knowledge. Our position and circumstances have been shown by it to be, if not quite peculiar, at any rate very far from inevitable. It has reduced by a process of exclusions to a relatively limited number the class of stars that can fairly be regarded as possible centres of vitality; it has immensely widened the scope of discernible variety in cosmical arrangements, and held out warnings against errors of interpretation due to congenital prepossessions. And we shall surely not wander from the truth by recognising our inability to penetrate all the depths and intricacies of Infinite Design.

To Prevent the Stripping of Photographic Films.

In warm climates it is often most difficult to prevent the gelatine film from becoming detached from a plate during development, and the usual methods, such as adding a little alcohol to the developer are not sufficient. Other methods are objectionable on account of their effect on the development or fixing. M. Mercier has lately tried, with good effects, tannin the gelatine. A bath is made up of the following :—Alcohol (90°) 250 cc, tannin 60 gr., water 500 cc. The plates are immersed for two or three minutes in this bath, after which they are carefully washed before being placed in the developer. The final washing must be continued until all traces of tannin have disappeared.

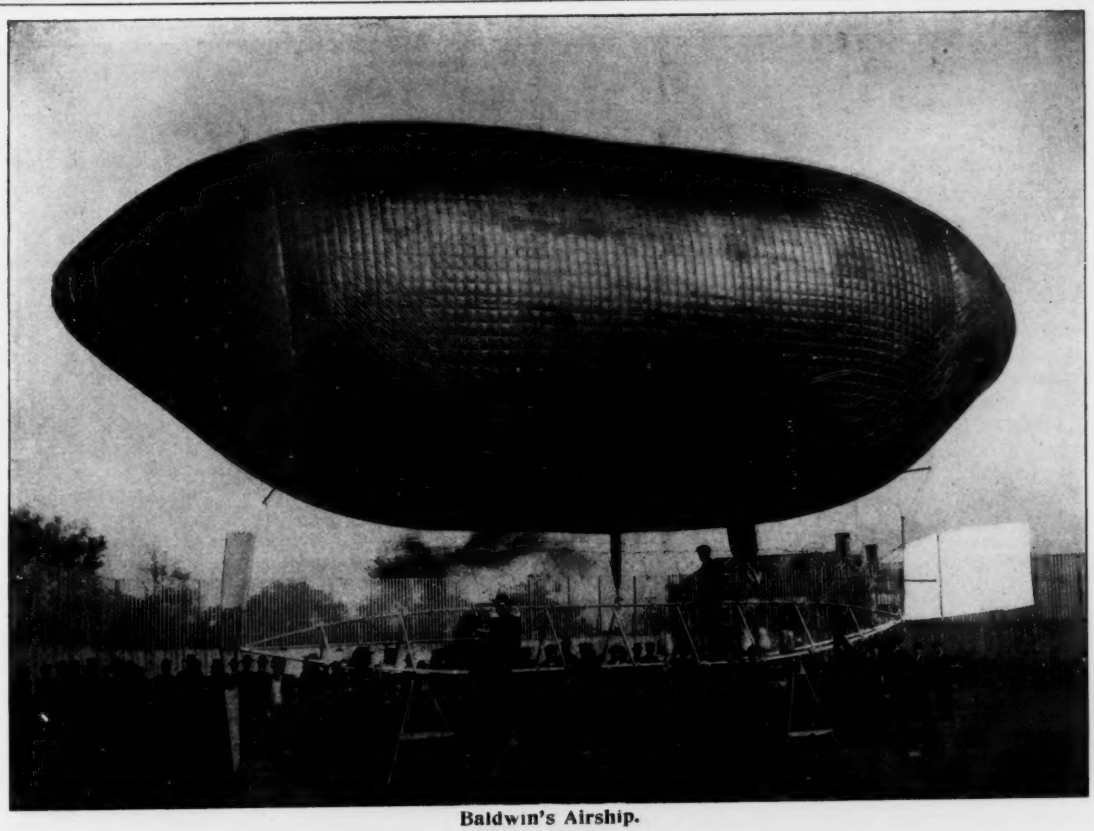
Progress with Airships in 1904.

By Major B. Baden-Powell.

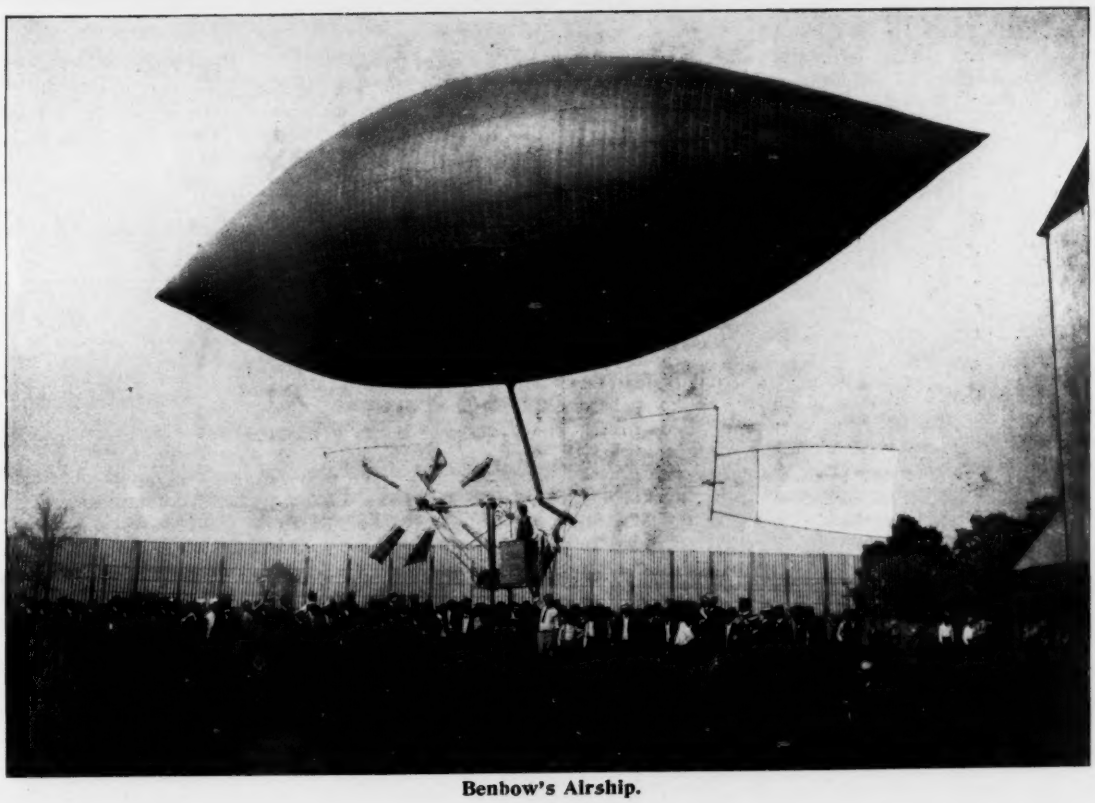
Notwithstanding the very tempting bait of a prize of £20,000 for an airship capable of attaining certain speeds over a fixed course, the competition in connection with the World's Fair at St. Louis can hardly be characterized as a success. Not only was there a lack of machines specially built with the object of carrying off this prize, but there was even a noticeable absence of those in existence which might have been able to comply with the conditions. M. Santos Dumont, for some reason not yet clearly explained, withdrew after taking his powerful new airship across the Atlantic. MM. Lebaudy do not seem to have had any intention of submitting for trial their most successful machine, nor did M. Deutsch send over more than a model of his " Ville de Paris." But what is even more unaccountable is that American inventors, such as the Messrs. Wright and Prof. Langley, were conspicuous by their absence, and did not enter their flying machines even for show. The rumours we have heard of Mr. J. P. Holland, of submarine-boat fame, and Prof. Graham Bell, the inventor of the telephone, having respectively devised new apparatus to navigate the air, have received no corroboration from St. Louis.

However, it cannot be said that there were no airships at the Fair. Three of them were open to inspection in the huge sheds specially constructed for housing the competing vessels. Two of them actually made ascents, and with some success. Unfortunately, the most promising of the three, that of M. Francois, could not even be inflated with gas. This apparatus consists of an elongated balloon of 1,150 cubic metres, supporting a wooden car containing a 25-28 h.p. Lambert water-cooled petrol engine (weighing 270 lbs.), which rotates two pairs of screw propellers. There are two horizontal shafts, one on each side of the car. Each of these has a propeller mounted on each end of it. The fore screws (about 9 ft. diameter) are smaller than those in rear (12 ft.), the idea being that the larger after screw will be able to effect a bigger column of air without, presumably, having so much work to do as if the smaller screw had not already acted on an inner column of air. The reasoning of this may not seem to be quite sound, but practical trials alone could prove if there was anything in it, and we can but watch for results.

Mr. Baldwin, whose name was much before the English public some 15 years ago on account of his bold and sensational parachute descents, exhibited an apparatus of the Santos Dumont type. As may be seen from the photograph, the elongated balloon supported a long trussed-girder beam, towards the fore-end of which was a two-cylinder petrol engine of 5 h.p. (almost hidden, in the photograph, by the figure of Mr. Baldwin). A tractor screw was placed at the fore-end. This was 10 ft. in diameter, the blades being each 3 ft. 4 ins. long by 2 ft. 2 ins. wide. A large rudder was placed behind, moved by tiller lines. This machine made its first ascent on October 25, piloted by Mr. Knabenschue. There was a light wind blowing, about six to eight miles per hour, but this proved altogether too strong for the airship, which made several turns around, but failed to stem the breeze, and was carried away over the town of St. Louis. Some days after-

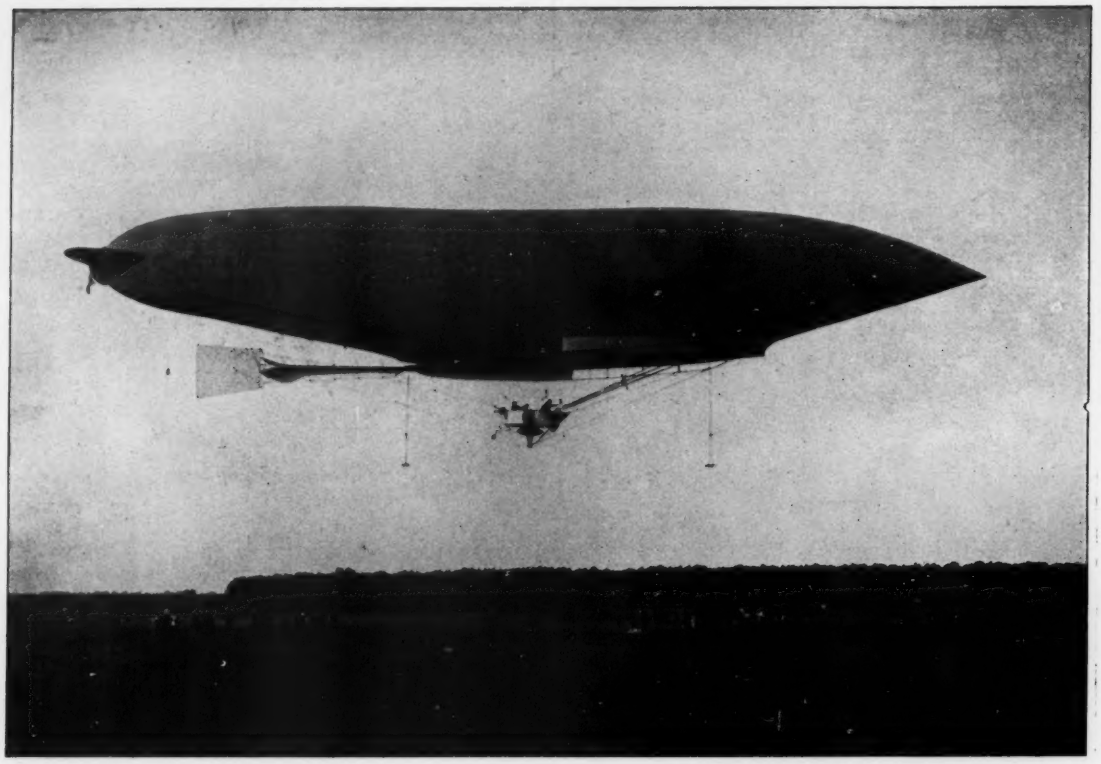


Baldwin's Airship.



Benbow's Airship.

XUM



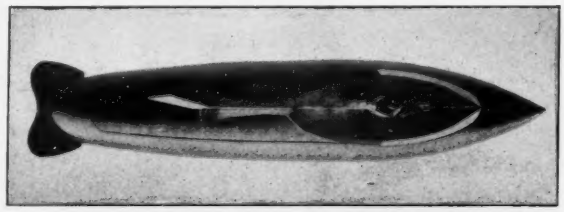
The Lebaudy, 1904.

wards, however, during a calm, a more successful voyage was made, and the vessel, after taking a tour above the Fair grounds, returned successfully to its point of departure.

The third machine was that of Mr. Benbow. This was a beautifully-shaped balloon of 73 ft. long by 20 ft. greatest diameter, with pointed ends, beneath which was suspended a car-frame of angle-steel carrying a pair of feathering paddle-wheel propellers. A 4-cylinder engine developing 10 h.p. rotated these wheels, which were so constructed that normally the blades were opened while passing the lower portion of their path and closed while going over the upper half of the circle. But by an ingenious arrangement of cams this action could be altered, so that instead of driving forward, it was possible to cause the propellers to give an upward thrust, or even to reverse and give a downward or backward thrust. This arrangement may be good in theory, but it was palpable that much power was lost in the gearing and complication necessary. This apparatus was tried on several days in almost dead calms, but owing to insufficiency of lift it ascended to no great height. It was, however, well able to exhibit its powers, and the exact rate of progress could be measured. The fans revolved at exactly one revolution per second, and the airship progressed at a rate of just about three miles an hour, this being, of course, altogether insufficient for a practicable airship.

But while these more or less abortive attempts to further progress with airships were being carried on in America, some really important work was developing on this side of the Atlantic. France, the birthplace of the balloon and the country in which nearly all the more notable advances in aërial navigation have taken place, now contains what may undoubtedly be called the first really practicable airship.

It will be remembered how, in November, 1903, the Lebaudy airship, which had had so wonderfully successful a career, came to grief, while landing at Meudon.



The Lebaudy from Underneath.

(This apparatus was fully described in the *Illustrated Scientific News* of September, 1903.) The vessel was completely wrecked, but M. Julliot, backed by the affluence of MM. Paul and Pierre Lebaudy, at once started on the construction of a new machine. This has now been completed, and has undergone its trials with much success. The new machine is practically of the same design as the old one; indeed, most parts of it are the same, repaired. The gas-vessel is new,

having a somewhat different shaped stern and containing a rather larger volume of gas, namely, 2,600 cubic metres (94,000 c. feet). It is 58 metres long over all; the greatest diameter, 9 m. 80, being 24 m. 90 from the bow. The length is therefore about 5.6 times the maximum diameter. The surface of the balloon is about 1,300 square metres, and the weight of the envelope is 550 kilos. The material consists of four layers, one of cotton-cloth with a layer of caoutchouc, one-tenth of a millimetre thick, then another of cloth, and finally one of caoutchouc on the inside.

The former balloon had only two layers of cloth with caoutchouc between, but it is hoped that this extra layer will preserve the cotton from impurities in the gas. The balloon is also varnished with seven coats of a solution of caoutchouc in benzine, vulcanised with sulphur, and is painted yellow outside, so as to prevent the actinic light affecting the caoutchouc. So gas-tight is this material that 48 hours after its inflation there was no appreciable loss of gas.

The ballonnet, which can be filled with air as desired so as to keep the balloon taut, is of 500 c. metres. The ventilating-fan for this purpose is driven by the motor, but, when the latter is not working, may be driven by a small dynamo and accumulator.

In addition to the "manœuvring-valve" at the top of the balloon, there are some safety valves automatically opening under a pressure of 35 millimetres.

The lower portion of the balloon is flat, and is rigidly stretched on a horizontal oval framwork of steel-tubing; below this is a long vertical "keel" of steel tubing, covered with canvas, and at the after end of this is pivoted the rudder.

This horizontal plane and vertical keel impart great stability to the vessel while running.

One of the most notable features of the 1904 model is a large horizontal double-rudder or fin, placed at the stern of the balloon. This to modify or prevent any tendency to pitch. There are also two small horizontal rudders at the rear of the keel-frame, just in front of the vertical rudder.

The car, as before, is suspended from the oval steel frame by wire ropes, the thurst of the propellers being conveyed to the main vessel by a system of rigid steel tubes leading from the front of the car to the front of the oval frame.

The propelling mechanism is the same as in last year's machine. A 4-cylinder Daimler motor of 40 horsepower, running at speeds from 250 to 1,200 revolutions per minute, rotates the two screw propellers, one on each side of the car. These screws are 2 metres 44 in diameter and rotate 800 to 1,000 times a minute.

The first voyage of the new airship took place on the 4th of August. This, however, only lasted some twelve minutes, being but a trial trip to test the engines and steering arrangements. Everything proved highly satisfactory, and a few days later a second journey was undertaken. The wind on this occasion was blowing 13 miles an hour, yet the vessel rose and manœuvred around for a quarter of an hour at a height of 60 to 80 metres above the ground.

Several other short trips were successfully made on succeeding days, and on the 16th of August a longer journey was undertaken. This lasted 41 minutes, during which time the balloon covered a distance of about 26 kilometres (16 miles). On the 28th of August another ascent was made, and after 20 minutes of circling above the grounds, the airship descended and the aëronauts got out. Just then a strong gust of wind caught the balloon, the tethering ropes both snapped, and the balloon rose and floated away without any occupant! Instead of rising, as might have been expected, to a considerable height and being carried off to a great distance, the balloon seems to have kept low and to have several times actually touched the earth. Eventually it got caught up in a wood, 70 kilometres from its point of departure, and was deflated and taken back to its shed, having suffered but little damage.

A number of other voyages were made later on, including one on the 22nd of November, which lasted for 1 hour and 33 minutes.

On the 22nd of December, the last voyage of the year was made, this being the thirtieth during 1904, and the sixty-third trial of this type of airship. All these trips were conducted by M. Juchmès, the aëronaut, who was usually accompanied by a mechanician and an assistant, and on several occasions a passenger was also carried.

To have accomplished all these journeys in varying weather, and, with one exception, each time to have safely returned to its shed, seems to prove that in this airship we really have at last a machine capable of navigating the air, and the promoters would appear quite justified in alluding to it, as they do, as the "aërial cruiser."

The Herschel Memorial

MR. J. P. MACLEAR writes from Beaconscroft, Chiddingfold, Godalming: "I was doubtful about the inscription I sent you for the north side of the Herschel Obelisk at Claremont, Cape of Good Hope. I now send an exact copy."

Bronze Tablet (about 11 × 15 inches) of a Latin Inscription for the Herschel Obelisk at Feldhausen, Cape of Good Hope.

W. J. Herschel, Scripsit, May-July, 1904. Photo. by A. S. Herschel, Sep'., 1904.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Dr. Russell's Experiments.—Last month I referred to the production of the developable condition by emanations from various substances as in Dr. Russell's experiments, and showed that although some results appear to indicate that the effect is due to a gas, and that this gas is the vapour of hydrogen peroxide, others are generally allowed to be difficult to account for on this simple hypothesis.

Professor J. Joly, in a letter to *Nature* last August, asks with regard to Dr. Russell's experiments and his suggestion that peroxide of hydrogen is the active agent, "ought we not rather to seek the explanation in the ionising properties of metals indicated by other observations?" He founds this question on his observation that pure mercury and polished speculum metal in contact with a rapid plate under absolute alcohol in an airtight desiccator over calcium chloride produced the developable condition in a gelatino-bromide plate just as vigorously as if it were obtained in ordinary moist air. It is, perhaps, worth while to sum up the recorded experiences of Dr. Russell with regard to conditions similar to those described by Professor Joly.

As to mercury, Dr. Russell found that, if pure, it was inactive, and that an active sample might be made inactive by purification, and that if pure and inactive the addition to it of one-thirty-thousandth of its weight of zinc rendered it very active.

As to moisture, Dr. Russell at first found no difference whether the action took place in air saturated with moisture or air dried with sulphuric acid or calcium chloride, or in an atmosphere of hydrogen. Later on, when he had found how intimately hydrogen peroxide was connected with the results obtained, he remarks that a gelatine plate is never really dry. He seems to have repeated the experiment of trying the different effects of an atmosphere dried by calcium chloride and an atmosphere kept moist, and found that after three days "the damp plate had much the darker picture on it." By passing dry air over zinc nothing was given off that affected a plate, but when moist air was passed over the metal and then allowed to impinge on the plate, the change was effected. He found also that dry alcohol neither transmitted the action nor was made active by putting zinc in it, but by adding the merest trace of water to the alcohol, the zinc did make it active.

Messrs. Blaas and Czermak (Science Abstracts, Section A, No. 2559, 1904) record the old and well-known fact that many substances after exposure to light are able to affect a photographic plate, or affect it more readily than they did before insolation. They say that this property is connected with the occlusion of ozone and that bright or amalgamated zinc possesses the property, and that many substances emit a diffuse radiation which is reflected at mirror-like surfaces. Dr. Russell states that he found ozone to be without effect, and in a communication to the Royal Society last June dealt with the effect of exposure to sunlight in rendering "active" substances more active. He says that "bodies other than those which may contain resin or allied substances are not affected in this way by light." "Metals are not rendered active by sunlight."

Dr. Luppo-Cramer finds that while a gelatino-bromide plate is affected by hydrogen peroxide, a collodio-bromide plate is not, and hence considers that the gelatine has a vital influence on the result. But his experiments are not strictly comparable with Dr. Russell's, as he immersed his plates in weak solutions of the peroxide, though he considers that this is the same in effect as exposing them to its vapour. I believe it has been observed that films apart from the glass support are not affected by these emanations. Thus it would appear that the glass, which is not permeable by them, is necessary to prevent them passing through the gelatine film and escaping with the production of little or no effect on the sensitive salt.

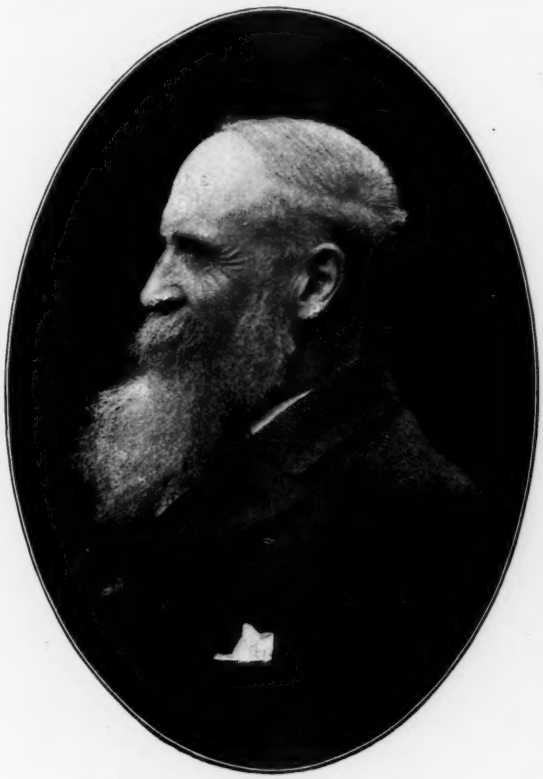
There are many other observations that bear upon this subject in a more or less direct manner, but I think that I have set down sufficient to show that there remains a considerable measure of uncertainty with regard to some of the observations, and that it is impossible to rest satisfied with the suggestion that the effects are the simple results of the action of peroxide of hydrogen. The peroxide doubtless has something to do with it, and, perhaps, is itself one of the effects of the action rather than the cause. We do not yet know how silver bromide is changed when it assumes the developable condition, though the evidence is very strongly in favour of a merely physical alteration. Such an alteration seems more likely to result from the impact of some form of radiant energy, than to be the direct result of mere contact with such a substance as peroxide of hydrogen.

The Use of the Optical Lantern.—Projection lanterns are often used in such a manner that one might well suppose that they are regarded simply as "magic" lanterns, and that so long as an enlarged image of the slide is produced on the screen, and that the image is tolerably well defined and sufficiently bright, every desirable condition has been fulfilled. Some, though not many, go so far as to consider the convenience of the audience and endeavour to arrange so that the middle of the screen is, at the highest, about level with their eyes. Still fewer pay attention to what should be one of the simplest and most primary of rules, namely that the image on the sheet ought never to be seen to move or vary in any way in the matter of adjustment. But there is very much more than this in the correct use of a lantern. There is a proper point from which every flat representation of a solid object or view should be looked at, and the skilful or scientific exhibition of a picture renders it at least possible for the observer to see it from this point or from a position at a similar or greater distance. If a three-inch slide is printed by contact from a negative taken with a six-inch lens, the viewing point is always equal to twice the length that the full three inches would be represented by on the sheet. If a twelve-foot sheet would be covered by the three-inch slide, the nearest spectator should be twenty-four feet from the sheet. Under these conditions the view as shown will subtend the same angle (or a less angle, allowing for the spectators who are behind the front row) as the original view did from the position at which it was photographed. But suppose the hall is not large enough to allow of such a distance, some may object. If the distance between the front row and the sheet cannot be more than twelve feet, then bring the lantern nearer and give a six-foot picture, and the conditions are fulfilled. Of course, size counts for something, but mere size, mere exaggeration is contemptible.

XUM

The Late Rev. J. M. Bacon.

WE are able to present an excellent likeness of the late Rev. John Mackenzie Bacon, F.R.A.S., whose sudden death at Christmas was so widely deplored. Born in 1846, and educated at Trinity College, Cambridge, he was ordained in 1870, and for some years was curate at Harston, Cambridgeshire. Latterly he had not taken regular duty, but had devoted himself to scientific pursuits. At his home at Coldash, near Newbury, he had a small observatory, and he took part in three expeditions to observe eclipses of the sun. He had



THE LATE REV. J. M. BACON.

also conducted numerous interesting experiments in acoustics and in meteorology. But his name was most widely known as an intrepid balloonist, he having for many years made frequent ascents in the cause of science, often accompanied by his daughter, Miss Gertrude Bacon. He published two books on the subject—"By Land and Sky" in 1900, and "The Dominion of the Air" in 1902.

Mr. Bacon has contributed many interesting articles to "KNOWLEDGE," and we now have one in hand on "Seeing beneath the Waves," which we hope to publish very shortly.

Heredity.

THE continuation of Mr. J. C. Shenstone's article has unfortunately been crowded out this month, but will appear in our next issue.

SIR WILLIAM TURNER on The Craniology of the People of Scotland.

By DR. J. G. MCPHERSON, F.R.S.E.

THE learned Professor of Anatomy in the University of Edinburgh has just received the Keith Prize from the Royal Society of Edinburgh for his "Contribution to the Craniology of the People of Scotland."

For several years he has been forming a collection of Scottish skulls with a view of studying the characters of these skulls. He has had considerable difficulty in acquiring a suitable number from which to determine the *type* skull of the Scottish people. A great number of the skulls available to a professor are of necessity from the bodies of the pauper part of the community; and these can give no proper conception of the cranial type of the well-educated and well-to-do classes.

Through the kind interest and help of his many former pupils and friends, Professor Sir William Turner has obtained skulls from definite districts all over Scotland. But Edinburgh, Haddington, Fife, and Mid-Lothian have furnished him with a considerable proportion of the number. He has, in this way, been able to study one hundred and seventy-six skulls outwith the ordinary stock of anatomical specimens; and these represent the characters of the skulls of the people of Central Scotland.

After a very careful and minute examination of these specimens, the Professor drew some definite conclusions as to the form, dimensions, and proportions which prevailed in the crania generally. The shape of the cranium, from its influence on the form of the head and from its connection with the brain which it once enclosed, has for long attracted the attention of anatomists. The relations of the length to the breadth and the grouping of skulls into the "elongated" and the "rounded" have been of much importance in determining the distinctions of the human races. But the Professor has combined observations on the shape of a skull with exact measurements.

The measurements are taken with callipers in straight lines between certain definite points, in order to ascertain the length, breadth, and height of the exterior of the cranial box; with a graduated tapeline over the curved walls of the outer table, the arcs and circumference are determined; and with small shot the internal capacity is known.

Speaking generally, Professor Turner has concluded that the Scottish skull is large and capacious. Its vertex has a low, rounded arch in the vertical transverse plane. Its side walls are not vertical, but they bulge slightly outwards, so that the greatest breadth is at or near the squamous suture.

In the men the longest skull was eight inches, and the shortest 6½ inches, the mean being 7.35 inches. In the women the longest skull was slightly over 7½ inches; the shortest was 6.34 inches—the mean being seven inches. The length of the Scottish skull indicated a brain longer than existed in the long-headed black races.

Professor Turner found that in the men the broadest skull was 6¼ inches, and the narrowest 5.12 inches—the mean being 5.86 inches. In the women the broadest skull was six inches, and the narrowest five inches—the mean being 5.43 inches.

XUM

Thus the average male skull is longer than that of the female by .35 inch, and broader by .43 inch.

The cephalic index expresses the relation which the greatest breadth of a skull bears to its greatest length. In these skulls examined by Professor Turner, the index ranged from .87 to .68; the mean in the men and in the women being about the same, .77; that is, in the short-headed class. From this it is clear that a strong short-headed strain pervades the population of Scotland at the present time. The Scottish people may be long-headed in calculation and logical acumen, as is often mentioned as a social characteristic; yet anatomically this is not the case.

The vertical index expresses the relation which the height bears to the maximum length. This index ranged from .64 to .79. The mean in the men was slightly more than in the women, approximating .71.

The relations of the length to the breadth and to the height of a cranium have long been recognised as important subjects of investigation in the study of racial characters of skulls; but the relations of the breadth and height to each other have not had an equal attention given to them. In well-pronounced long-headed races like the Esquimaux and Australians, the height is greater than the breadth, forming a high, narrow skull. In the short-headed races, like the Chinese, the breadth is greater than the height, indicating a wide, low skull. A striking feature of the Scottish crania is the preponderance of the cephalic index over the vertical index; accordingly they are of the type "wide low" skull.

Professor Turner's measurement of the horizontal circumference of the Scottish skulls brought out these facts:—In the male, the maximum is 22½ inches; minimum, 19¼ inches; mean, 21.9 inches. In the female, maximum, 21.65 inches; minimum, 18⅓ inches; mean, 20 inches; so that the average horizontal circumference of a man's skull is greater than that of a woman by about two inches. His measurement of the vertical across circumference brought out these facts:—In the male the maximum is 18¼ inches, the minimum 15¾ inches, and the mean 17 inches; in the female, the maximum 18 inches, the minimum 15 inches, and the mean 16 inches; so that the average vertical transverse circumference of a man's skull exceeds that of the female by an inch.

One of the most important series of measurements was of the total longitudinal arc of the skull (including the frontal, parietal, and occipital arcs). The maximum male skull was 22 inches, the minimum 18.4 inches, giving a mean of 20¼ inches; the maximum female skull was 21.1 inches, the minimum 17.3 inches, giving a mean of 19¼ inches; so that the average longitudinal circumference of the male skull exceeds that of the female by an inch.

The Professor took the internal capacity of the skull with small shot. And he found among the 115 crania examined (73 males and 42 females), that the maximum capacity in the male skulls was 118¾ cubic inches, the minimum 78¾, and the mean 94½; in the female, maximum 104, minimum 70, and average 84½ cubic inches. This shows that the female skull is about 10 per cent. less capacious than the male. This agrees with the approximates of the skull capacities of other races and peoples. In a series of comparisons he found that the capacity of the Scottish male skull is somewhat in excess of that ascribed to the crania of European men. He does not, however, conclude from this that the Scottish men have a superior intellectual endowment. Many other factors than the volume of the cranial cavity have to be taken into consideration in the estimation of intellectual power.

In the study of the face it is important to determine the degree of forward projection of the upper jaw. Sir William Turner found that the Scottish skulls are characterised by an almost complete absence of prognathism (projecting jaw). The relation between the height of the nose and the greatest width of that aperture contributes one of the most important anthropological characters of the face. In the males he found the mean height was 2.10 inches, and in the females, 1.96 inches. The width in the males averaged .91 inch, in the females .87 inch. The height, therefore, is more than twice the width; and the occurrence of wide nostrils in the Scottish face may be regarded as accidental, and due, perhaps, to intermixture through an ancestor with that peculiarity. The customary form of nose in Scotland is long, relatively narrow, with a well-marked bridge, and projecting so that the nose distinctly projects beyond a line drawn between the front part of the two cheek bones.

Another important character is the relation between the length and breadth of the face. Professor Turner found the mean length in the males to be 4.72 inches, and in the females, 4.28 inches; he also found the mean breadths to be 5.20 and 4.78 respectively. The breadth of the face is about half an inch greater than its length.

The entire jaw had, in most of the specimens, a massive appearance, which had materially contributed to give character to the face, and from the marked vertical diameter of the body of the bone, had constituted an important factor in giving to the entire face a length which placed it distinctly in the group where the face is high in relation to the width. The lower jaw had a well-defined angle, and the body of the bone was massive on the males, and with a pronounced chin.

Photograph of Electric Spark.

PERHAPS it is not exactly correct to describe this as a *photograph*, since light plays no part in its production. It may more properly be called an "electrograph." The manner in which such representations of electric discharges are produced is as follows:—An ordinary photographic plate, enclosed in two light-proof paper bags (as used in X-ray work), is placed film upwards on a metal plate, which is insulated. The pointed dischargers of an induction coil, in this case one giving a 10-inch spark, are placed a few inches apart, touching the paper envelope. The circuit is then closed, and a single discharge brought about by holding the hammer of the coil and letting it go suddenly. The spark in its passage through the sensitive film decomposes it. The negative is then developed in the ordinary way. Variations of many kinds may be made by dispensing with the metal plate, or by placing the wires one above and one directly below the negative, or by using knobs on the dischargers instead of points.

One of the most interesting points to note is the difference between the positive and negative discharges, the former being "tree-shaped," while the latter is feathery or "fan-shaped." With a single spark both structures are often shown, owing to the oscillatory nature of the discharge. The photograph here reproduced was taken by Mr. Hudson, of Harringay.

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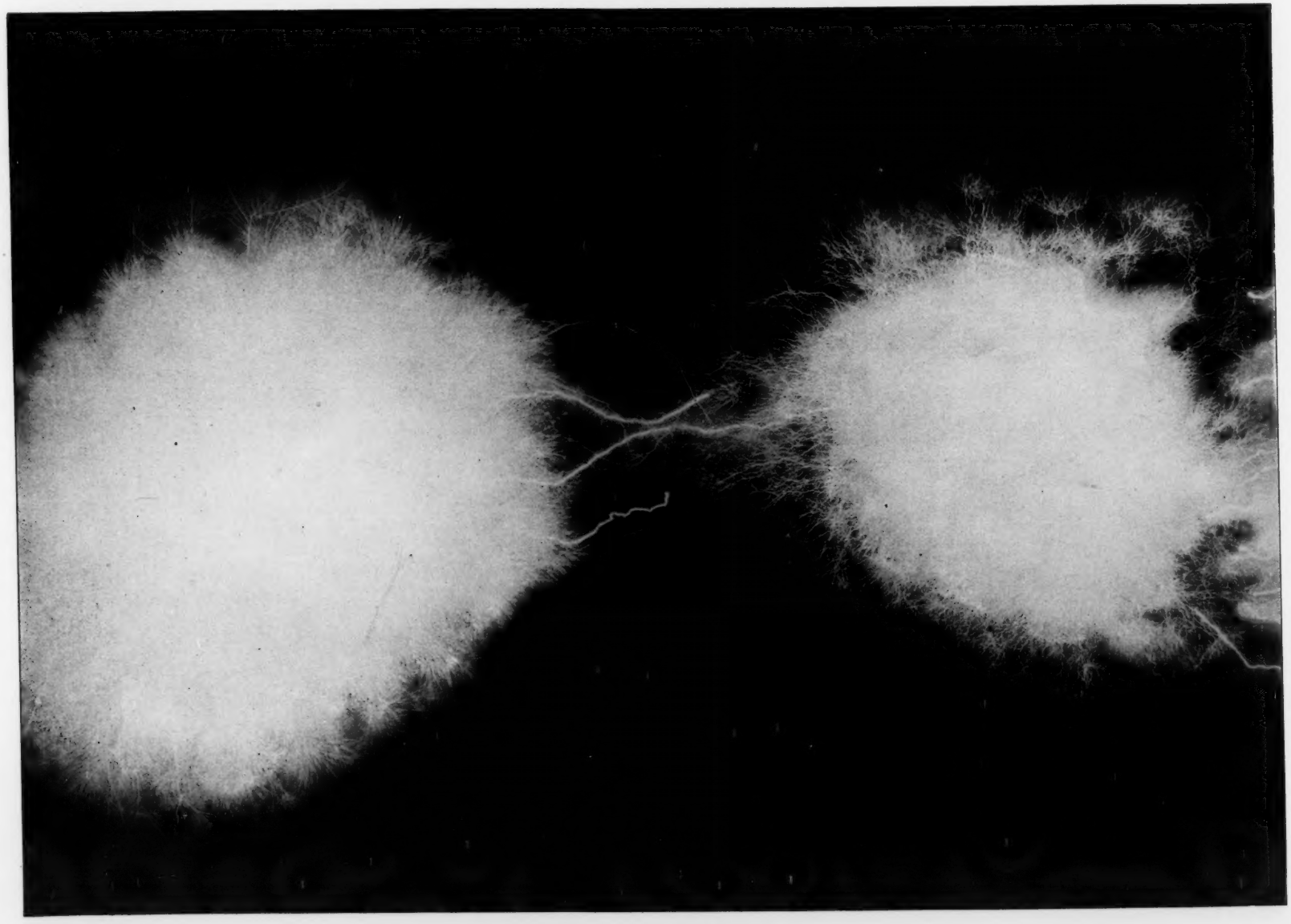

Photo by S. C. Hudson,
601, Green Lanes, N.

SPARK ELECTROGRAPH.

Our Sun and "Weather."

By WILLIAM J. S. LOCKYER, M.A., Ph.D.

(continued.)

IN confining this study, therefore, to pressure, the first step is to see whether the pressure does change from year to year, and then, if it does, to see if the curves which indicate this change are similar to those which represent the variation in the number of the solar prominences. Taking the Indian region, for reasons previously given, the reader will notice that the Bombay curve in fig. 7 does exhibit short period waves which agree for many years with those on the solar prominence curve; it is important to note, however, that the main eleven-year variation of the prominences is not so conspicuous as the shorter-period changes. The apparent secondary nature of the former and the pronounced character of the latter is a conspicuous feature of pressure curves nearly all over the world. It will be gathered, therefore, that greater attention must be given to this short-period barometric change.

SINCE the rise in the prominence curve denotes greater solar activity, and this is coincident with an excess of atmospheric pressure over the Indian area, and since this latter means that a greater amount of air than usual is piled over India, some part of the world should be experiencing the reverse conditions; in other words, there should be a large area on which a deficiency of atmospheric pressure exists simultaneously. Now this is exactly what happens, only one has to go to the other side of the world to find the locality. In such a region, then, the curve representing the pressure variation should be the reverse of that of India, that is, when there is excess pressure in one year in India there should be in the same year a deficiency in the other. If the reader will glance at the accompanying diagram (fig. 7) he will see the curve of the pressure variation at the observatory at Cordoba in South America, a locality in nearly the antipodal part of the world to India. This curve is nearly the exact opposite in every detail, and if one be reversed and compared with the other their similarity can be more easily observed.

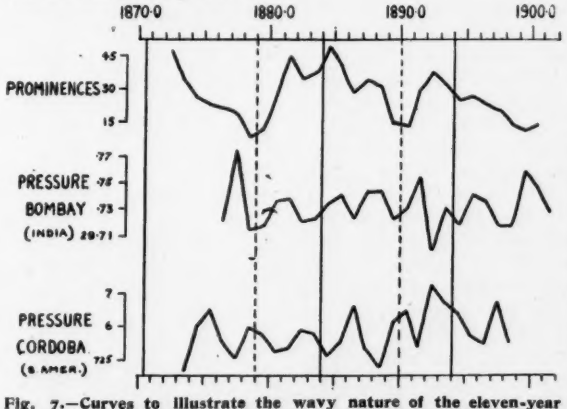

Fig. 7.—Curves to illustrate the wavy nature of the eleven-year prominence change and its relation to the atmospheric pressure variations that simultaneously occur in India and S. America.

The fact that when there is an excess amount of air over the Indian area in some years, and a corresponding deficiency over the Cordoba region during the same years, or a deficiency over India when there is an excess over Cordoba, makes one immediately inquire, What occurs at other places on the earth's surface? Such an investigation has led to some most interesting conclusions. Australia, for instance, like Arabia, Ceylon, East Indies, Straits Settlements, East Africa, Mauritius, &c., behaves like India. On the other hand, South America, the southern parts of the United States, and Honolulu, resemble the Cordoba type of pressure variation. Thus we have the world divided into two portions which behave in opposite ways as regards these barometric changes. As was to be expected, those regions neighbouring the limits of these two large areas are somewhat indeterminate, and sometimes favour the one and sometimes the other. The accompanying map (fig. 8) will

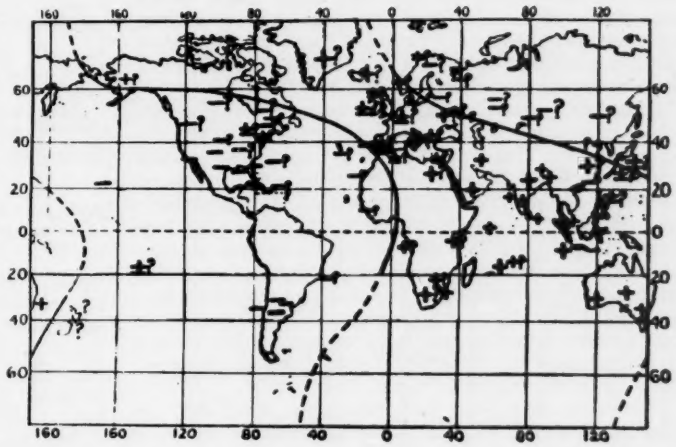

Fig. 8.—Map illustrating the positions of the two large pressure area types, namely India (+ and +?) and S. America (− and −?), which behave inversely to each other. The neutral line approximately divides the earth into two equal portions.

convey at a glance this pressure distribution, the Indian and Cordoba regions being indicated by a (+) and (−) respectively; the indeterminate areas are shown by a (± ?). The latter can be easily seen by following the track of the neutral line which approximately divides the eastern and western hemispheres.

The detection of this pressure variation may turn out to be an important clue to the close connection between the meteorological behaviour of regions which are widely separated. Thus to mention one of many incidences, Sir John Eliot has recently pointed out that the drought in the Indian region during the years 1895-1902 was a more or less general meteorological feature of the whole area, including Abyssinia, East and South Africa, Persia, Baluchistan, Afghanistan, probably Tibet, and the greater part or whole of Australia. Since these areas all lie within the Indian type of pressure variation above described, their meteorological connection seems undoubted.

Many people are more familiar with rainfall variations than they are with those of pressure, so that the importance of the latter can best be shown by indicating how rainfall is affected by pressure. As a general rule low pressure means increase of rain, but this is not always the case. The main point to be considered in this connection is the nature of region, that is, whether it is land or water over which the air current has passed, before it reaches the area in question. Thus what may be a rain-

bearing current for one part of a continent may under similar low pressure conditions be a dry one for other parts and *vice versâ*. The lie of the land in relation to the water surface must, therefore, in every case be taken into account, and it is for this reason that the direction of the prevailing winds becomes one of extreme importance.

In the first place, let the pressure and rainfall of the west coast of India and Ceylon be compared, but in both of these cases the rainfall of the south-west monsoon period will be dealt with alone. India, as is well known, receives its greatest quantity from the strong moist air current which strikes the country from its south-west quarter. The strength or weakness of this current means prosperity or poverty to the country. A failure of these rains foretells for many districts a terrible drought and consequently loss of crops, a famine, and a great expenditure of money. Since the west coast of India is most exposed to the south-west monsoon wind, and is not shielded by mountains except on its eastern side, this region should respond in its rainfall to the pressure variations. In the Ceylon rainfall curve only those months have been included during which the south-west monsoon wind is blowing.

In order that the reader may more easily compare curves of pressure with those of rainfall, the former have been inverted. The highest points of the pressure curves therefore mean lowest pressures, and these correspond with the peaks of the rainfall curves which denote years of greatest rain. A glance now at the accompanying diagrams (Fig. 9) will illustrate the close resemblance between these two meteorological elements. In both the rainfall curves similar kinds of variations seem to exist, but the rainfall of Ceylon appears to anticipate to a small extent that of the western coast of India. Thus years of low pressure for these regions mean, on the average, years of good monsoon rains.

Now, not only does this connection hold for this portion of India, but the same happens in the case of some parts of Australia. Years of deficient pressure there mean years of excess rainfall. Since

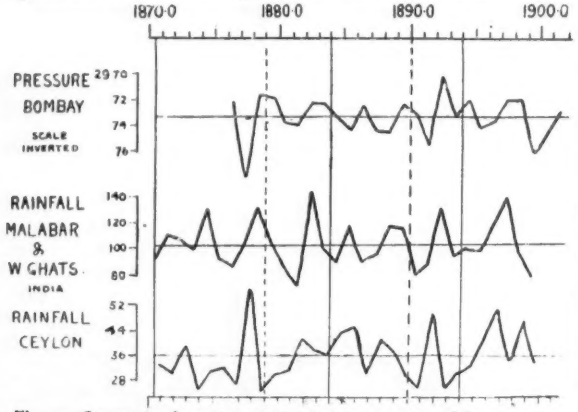

Fig. 9.—Curves to show the relation between years of low pressure over the India area and the rainfall on the west coast of India and Ceylon dur ng the South-West Monsoon period.

the pressure variations are nearly similar to those in India, good rains should occur in the same years. The annexed diagram (Fig. 10) shows the state of affairs at Adelaide, Perth, and Albany, the pressure curves of all these places being very similar. Excess low pressure corresponds to excess rainfall. What lack of rain means to this colony only those who have experienced a droughty season there can vividly testify; but the millions of sheep that have died through want of water in the last few years indicate the importance of the value of rain.

In our own isles a similar relation of pressure and rainfall holds good. Low pressure on the average means a greater number of cyclones, while high pressure means anti-cyclonic conditions on the average. The rainfall of Great Britain on the whole is chiefly dependent on the

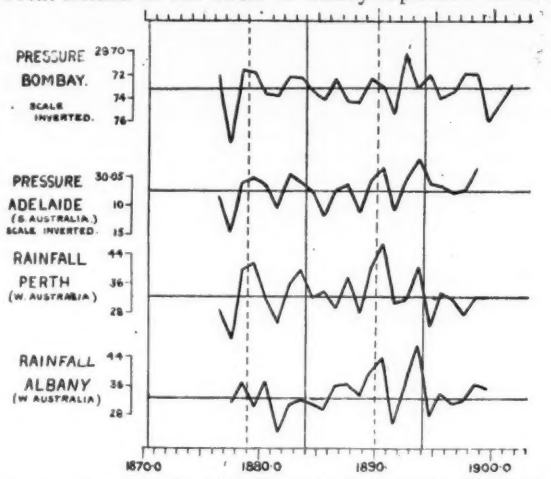

Fig. 10.—Curves to show the close relation between the pressure variations in India and Australia, and the rainfall in the latter country.

winds which reach this country from the Atlantic, that is south-west winds, or, in other words, on cyclones which pass over the country in a direction north-eastwards. Since cyclones denote low-pressure areas, the rainfall is directly dependent on pressure. A perusal of the accompanying diagram (Fig. 11) shows how intimate this relationship between rainfall and pressure is, for the curves (the pressure curve is here inverted) are so very closely similar.

Unfortunately, the British Isles, which display pressure variations intermediate between India and Cordoba, are a sort of half-way house, and have therefore rather a mixed type of pressure variation; there is thus some difficulty, with our present knowledge, in foretelling a year in advance whether the pressure will be in excess or deficient.

Although this short-period variation of pressure is, perhaps, the most important that is indicated in meteorological observations, and the reader can judge this from the curves here shown, it is not the only one acting. In many cases that have been examined, the most distinct variations are those which extend over several years, and correspond to the thirty-five year sun-spot variation previously described, and to that covering about eleven years. The prominence record is not sufficiently long to say whether this class of solar disturbance has a period of variation of thirty-five years, but the eleven-year change is most pronounced.

The thirty-five year weather cycle, or Brückner cycle, as it is called, because Brückner was the first to clearly demonstrate its existence, has for many years been suggested. Thus Bacon many years ago wrote: "There is a toy which I have heard, and I would not have it given over, but waited upon a little. They say it is observed in the low countries that every five and thirty years the same kind and suit of years and weathers come about again; as great frosts, great wet, great droughts, warm winters, summers with little heat, and the like, and they

call it the Prime." Again, in Australia there was an impression as long ago as the year 1836 that the seasons underwent a variation every nine or ten years, varying, however, every third series or thirty years.

Now Brückner has shown that there is a thirty-five year period both in pressure and rainfall, the years of high pressures corresponding to those of less rainfall. This long-period variation is of very great importance and must be reckoned with in long-period forecasting, although it is not so prominent as the short-period

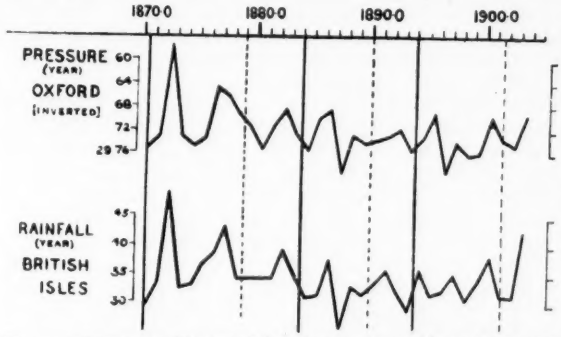

Fig. 11.—Curves to illustrate the close relationship between the variation of pressure over the British Isles (Oxford taken as the type) and the mean rainfall, from the Meteorological Office Statistics, over the whole of Great Britain.

changes that have been described above. The accompanying set of curves (fig. 12) will perhaps serve to illustrate this long-period variation of rainfall for a few stations on the earth's surface, while the curve at the top indicates the relationship between the epochs of the dry and wet periods and those of the great solar variation of thirty-five years described in a previous paragraph. It must not be forgotten that to determine this long-period variation from the rainfall records the means of several years have to be taken together, and even when every five-year values have been employed the resulting curves have to be again "smoothed," as it is called. In some of the cases it will be seen that the five-year means render apparent the eleven-year variation, a variation which seems more distinct in tropical regions, such as India, than extra-tropical regions.

A glance at the curves is sufficient to indicate the existence of these variations. From a study of these variations at many places scattered over the earth's surface, it has been found that the maxima or minima do not occur at the same epochs at all places; at present this question has not been worked out, but it may possibly turn out that, like the short-period pressure variation, there is a give and take between two large regions on the earth, in which while the maximum rainfall is occurring in one region the minimum is taking place in the other.

Fortunately for us who dwell in Western Europe, it will be seen from the curves that we are entering on a series of years, which, *on the average*, will be wet, after having just experienced a number of years during which the rainfall was very much below normal. The rainfall of 1903 practically put an end to this long drought. It is important to remember that the short period of about four years is the most prominent variation of rainfall, and is always at work. It is thus quite possible to have a comparatively dry year when the long-period rainfall variation is at a maximum, but on the average the wet years will he wetter and the dry years less dry at such an epoch. At the minimum of the long-period cycle the wet years will be less wet and the dry years more dry.

Enough, perhaps, has been said to show that the rainfall variations all depend on the atmospheric pressure changes that occur. These latter are apparently closely associated with the solar cycles whether they be indicated by spots or prominences. We are thus led to deduce the most probable—and, after all, the most natural—conclusion that the sun is the most important factor in producing our varied weather.

We have become acquainted with three periodic variations of solar activity, covering about four, eleven, and thirty-five years each. The question arises—Are there any other variations of longer period which may help to complicate the solar problem, and, consequently, the meteorological one as well?

It may be said, however, that no other periodic variation extending over a year has yet been traced, as the time over which the observations extend is at present too short.

The lengths of the periods which have up to now been discovered have, however, such a peculiar relationship to each other that perhaps a means is afforded of suggesting a fourth period. If we take the length of the shortest period as our unit—namely, 3·8, and multiply it by 3, we obtain 11·4, which is very near our second period, which is 11·3; if we again multiply 11·4 by 3, we have 34·2, which again is close to 34·8, the real value, as far as can yet be determined, of the thirty-five period. Now, if we multiply 34·2 by 3 again, we obtain 102·6, which may be the length of a new period. The above numbers, put in

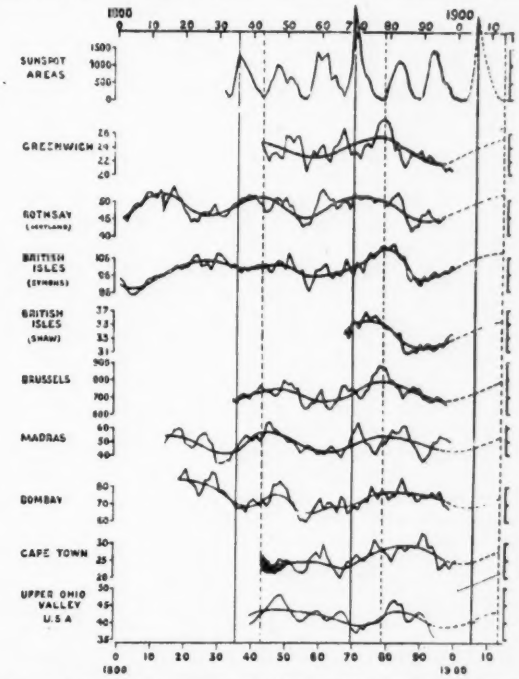

Fig. 12.—Some curves showing the long-period variations of rainfall and their relation to the 35-year solar change as indicated by the vertical dotted lines, and the eleven-year solar period.

tabular form, show the curious relationship between the periods perhaps better:—

3·8 × 1 =	3·8,	value actually	determined	3·8
3·8 × 3 =	11·4	"	"	11·3
3·8 × 6 =	34·2	"	"	34·8
3·8 × 9 =	102·6	"	"	?

To advance the knowledge of weather changes, solar variations must be most carefully watched. For a successful solution of the weather problem, the two sciences, Solar Physics and Meteorology, must go hand in hand, and the saying "unity is strength" no less applies to matters scientific than it does to other affairs of life.

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Water Finding with the "Divining Rod."

As a result of Prof. Wertheimer's announcement that he was about to undertake some careful investigations in the subject of water-finding by so-called "dowsers," quite a number of letters and articles have appeared in the *Times*, showing how widespread is the interest in this matter. These letters, too, when read as a series, give a very good idea of how the question stands. There are undoubtedly many people, and many of scientific experience, who seem to be firmly convinced that there is "something in it." Many of these are themselves "dowsers," though unable to assign any cause to the manifestations. Then, on the other hand, there are those disposed to ridicule the whole affair as an absurd superstition. But probably the majority of thinking people are of a medium opinion and are only anxious for evidence to convince them one way or the other.

The case for the unbelievers is soon summarized. There is almost as much evidence, as far as can be ascertained, of failures to find the predicted spring, as of successes. If one points haphazard to any spot on the ground, and a well be sunk at that place, there is a very good chance of water being met with. This probability, combined with a due consideration of the geological and topographical features, will be sufficient to enable a professional water-finder to make a good reputation. If he has the luck to hit off the right spot his fame will soon be spread. If he fails, the affair is soon forgotten.

But now let us assume that the marvellous manifestations have been fully and truthfully recorded. If certain persons, and only a limited proportion of mankind, possess the remarkable gift of being able to hold a twig in their hands in such a way that it shall be caused to violently rotate when held above a subterranean spring of water, then we are undoubtedly in the presence of an extraordinary force, the nature of which is entirely unknown to us.

In searching for a solution of the mystery there are two distinct propositions to be considered, since typical "divining" is only supposed to be possible when two factors are suitably combined. These are, a person endowed with the mysterious power, and a forked stick of certain dimensions and even a particular kind of wood. Sometimes, however, it is said that a wire or steel spring will do as well; while occasionally a "dowser" will declare that he can even tell of the presence of water without anything more than his open hand.

It is most unaccountable to suppose that a hazel twig of a particular shape and size should be affected while one of another sort of wood or slightly different form should not be affected. And the fact seems so contrary to nature and so little supported by scientific evidence, that we may, perhaps, dismiss this factor from investigation.

Then, again, there has to be considered the method in which the rod is held in the hands. It is usual to hold it in one particular way, and herein, it seems to us, is some slight clue. It will be found that if a forked stick of the usual dimensions be held in the orthodox manner, that is, with the tips of the forks enclosed in the palms of the upturned hands, a very slight movement of the hands in a particular way causes the base of the fork to revolve right round, and thus an almost unconscious pressure of the hands will often have an extraordinary effect. This can easily be appreciated by anyone even while sitting in one place and nowhere near any water, holding such a stick and trying to keep it pointing downwards, say for 10 minutes, on end. It may be, then, that a very slight convulsion of the nerves causes the stick to move. In other words, it seems probable that the divining rod is but an index of slight nervous sensations.

Then as regards the power of water-finding being confined to certain persons. This, unless it be that some people's nerves are more "highly strung" and more susceptible to be affected than others, seems quite contrary to all we know of the human frame. It is much more likely that only a few persons happen to have been successful, and are thenceforward supposed to possess the extraordinary faculties. Undoubtedly many people are exceptionally sensitive, for instance, to atmospheric variations. Old wounds and corns frequently indicate some change in the conditions quite beyond recognition by our other senses, and this is a subject that does not appear to have been at all thoroughly investigated.

We now seem to be arriving at a more rational problem. The next question to be considered is as to how the presence of a subterranean spring of water can be detected by the nerves. It is a matter of everyday occurrence to see, on still evenings, light mists hovering over the grass in particular places, and it seems not at all unlikely that such mists will usually be found suspended above the position of some underground spring. Is it, then, not probable that this patch of humidity can be ascertained by instruments even when the state of the atmosphere is not favourable to the formation of a visible mist? And if the air in this spot is different as regards humidity, temperature, or other property to that surrounding it, is it not possible that human nerves may be so affected that some very slight difference is felt? And if this is the case it is not difficult to suppose that someone holding a twig in a constrained position might find that in passing into such an atmosphere there was some slight relaxation or contraction of the muscles, and this would undoubtedly cause the twig to revolve. One of the correspondents also mentions how gnats are seen to congregate over particular spots. Whether this is due to dampness of air or other cause has, we believe, not been well ascertained.

Sir William Preece, in the *Times* of the 16th, brings forward another theory. He suggests that the running water may set up slight vibrations of the ground, which, he thinks, may act upon "the sensitive ventral diaphragm of certain exceptionally delicately-framed persons."

But then we also read statements that the same manifestations occur when, instead of water, a small quantity of gold or other precious metal is present. In this case we either feel that a very strong addition is made to the case in favour of the whole matter being a fraud or a delusion, or else that the mystery is one altogether too profound for us to attempt to apply the known laws of nature. One correspondent, indeed, tells of "a respectable farmer in this neighbourhood who could tell under which of several hats a sovereign had been placed." We know of many people who can do this, but without the aid of the divining rod. There is, however, much evidence as to the finding of lodes of metal ore. Another correspondent declares that he himself can locate lodes of copper or tin ore, and has done so with great success. If metalliferous ores can affect the hazel twig, the suggested theories of

humidity and vibration are quite inapplicable, and we must search for some further cause. Some people have vaguely ascribed the results to electrical manifestations, but ignorant people have a way of imputing (often, perhaps, with some truth) all unaccountable phenomena to electricity.

However, the subject is an interesting one and well worth careful investigation, and as Prof. Wertheimer has kindly promised to send us the results of his investigations, we shall look forward with much interest to the report. The *Times* suggests that "half-a-dozen men of ordinary ability, powers of observation, and common sense, could settle the whole question by putting half-a-dozen 'water-finders' to the test." If they clearly proved the dowsers at fault the whole question might be fairly settled, but if the water should invariably be found where predicted, the question would be very far from being settled. We would suggest that a beginning might be made, as it were, at the other end; that is to say, to conduct some careful scientific observations as regards the hygrometric, thermometric, electrical, and vibratory conditions of the earth and air at a spot beneath which a spring of water was known to exist. If peculiar conditions were found to exist, then we would know that there might, after all, be something in human "water-divining."

CORRESPONDENCE.

The Great Red Spot of Jupiter.

TO THE EDITORS OF "KNOWLEDGE."

GENTLEMEN,—In your note on p. 13 of the current number of "KNOWLEDGE & SCIENTIFIC NEWS," you are good enough to refer to some recently-published results by the writer relative to the motion of the above spot. May I, however, point out that my observations and conclusions are in agreement with those of Mr. Denning, and that they do not really "seem to indicate very different results," as stated in your note? The rotation period found here for the red spot in 1902 is 9 h. 55 m. 39·66 s., and for 1903 it is 9 h. 55 m. 41·52 s. Mr. Denning's figures for the same two years are 9 h. 55 m. 39·4 s. and 9 h. 55 m. 40·8 s. respectively (see the *Observatory*, 1904, p. 343). It will be seen that both Mr. Denning's observations and those made here indicate a distinct increase in the length of the rotation period. The shorter period of 9 h. 55 m. 38·6 s. ascribed to Mr. Denning refers to the first seven or eight months of 1904, and seems to be due to further vagaries in the motion of this truly remarkable spot.

Mr. Denning, I believe, observed the great hollow or bay in the south equatorial belt of Jupiter, nearly opposite to the red spot, whilst the spot itself was observed here. The periods of time over which the observations extended are also probably not exactly the same. These circumstances will probably account for much of the not very large differences between our figures quoted above. I believe that a shortening in the length of the rotation period of the red spot for the first seven or eight months of last year, similar to that pointed out by Mr. Denning, will also be shown by my observations, but these are still in progress, and I am anxious to avoid, as far as possible, making any examination or comparison of the results obtained until the close of the present apparition of Jupiter, so as to avoid being biassed as much as possible. The Rev. T. E. R. Phillips confirms, however, the more rapid motion of the spot in the first seven or eight months of 1904 (see *Journal. B.A.A.*, Vol. XV., p. 28). How far these somewhat curious changes in the motion or drift of the red spot are real, and how far they may be only apparent, and due to the changed surroundings of the spot, must be left to future consideration.

A. STANLEY WILLIAMS.

20, Hove Park Villas, Hove,
January 9, 1905.

NOTES.

ASTRONOMICAL.

A Sixth Satellite of Jupiter.

DURING December last, Professor Perrine, of the Lick Observatory, suspected the existence of a new satellite, but it was not till early in January that observations made with the Crossley reflector confirmed his suspicions. The distance from the planet was much greater than that of any of the other satellites, being then 45′. The motion of the satellite was reported to be retrograde, presumably referring to its apparent motion in the sky, and not to its orbital motion. It has a magnitude of 14.

* * *

Observations of Meteors.

Systematic observation of meteors was conducted at Harvard Observatory on November 14-15, four observers watching while an assistant wrote down the records. In this way 275 meteors were recorded. Though the heads at the time of explosion were usually blue or white, in two cases at least they were red or orange, which difference in colouring is ascribed by Professor Pickering to variation in chemical constitution. Elaborate preparations were also made to photograph the meteors, but only two trails were recorded on the negatives exposed.

* * *

Eclipse Expeditions.

Three expeditions are being arranged in connection with the Lick Observatory for observing the total eclipse in August. The cost of them will be borne by Mr. William H. Crocker. One is to go to Labrador, a second to Spain, and a third to Egypt. Photographs will be taken to endeavour to ascertain the existence of an inter-mercurial planet in addition to the photographing of the corona.

Death of Mr. Crossley.

The announcement of more important discoveries by means of the Crossley Reflector at the Lick Observatory has just been followed by that of the death of the donor of that great instrument, Mr. Edward Crossley, the Chairman of a great carpet manufacturing firm of Halifax, Yorkshire.

BOTANICAL.

By S. A. SKAN.

THE New Zealand Institute has lately issued Vol. XXXV. of its Transactions, which, like many of its previous ones, contains some important and extremely interesting papers relative to the botany of New Zealand and the neighbouring islands. We are reminded in Mr. W. W. Smith's communication on the "Plants Naturalised in the County of Ashburton" of the extraordinary number of alien species which have established themselves in New Zealand. In Ashburton the naturalised species number 368, of which as many as 95 per cent. belong to the Scandinavian flora. Many of our familiar weeds are abundant in this distant Colony, where they often flourish to an extent rarely known in their native country. A thistle (*Carduus lanceolatus*), Mr. Smith tells us, grows so vigorously in Ashburton that some places are rendered impassable, even on horseback. The late Professor Kirk, writing in Vol. XXVIII. of the Transactions, estimates the number of naturalised species in New Zealand as over 500, and he described the

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remarkable effects on the indigenous vegetation brought about by their introduction. When Cook and Vancouver visited New Zealand the constituents of the fauna and flora were, Professor Kirk observed, very probably in much the same condition as they had been in for many previous centuries. Altered conditions following the immigration of white people, the felling of forests, agricultural operations, and the introduction of various animals, many of which proved particularly destructive to vegetation, rapidly made a marked impression on the native flora. The clearing of the ground often meant the practical extermination of indigenous species, while it favoured the growth of aliens, seeds of which had been introduced in various ways, often mixed with agricultural seeds, in ballast, or by means of animals. That the stronger-growing species among the newcomers should spread and crush out of existence the weaker native plants is not remarkable, but we are told that the small slender-growing European grasses and clovers have in places succeeded in displacing such stout plants as *Phormium tenax*, the New Zealand Flax, and *Cyperus ustulatus*, a robust sedge. Rabbits and sheep have proved disastrous to many species, especially those with very local distribution. *Epilobium brevipes*, when Professor Kirk wrote, was restricted to two localities, and could easily at any time have been exterminated by a hungry rabbit or sheep. *Clianthus puniceus*, a handsome leguminous plant, is now confined to one or two small islands, where it owes its preservation to the absence of sheep. Both writers have noticed that many of the naturalised plants, after a period of remarkable vitality and vigour, diminish in strength and numbers and sometimes disappear altogether.

An account of a botanical excursion to the Southern Islands of New Zealand is given by Dr. Cockayne. These islands include the Auckland group, Campbell Island, the Antipodes and Bounty Islands. The visit was made during mid-winter, which enabled the author to note some previously unrecorded features of the vegetation. In Auckland Island, at about 50° 45′ south latitude, a single specimen of a common New Zealand tree-fern (*Hemitelia Smithii*) was found. This is a particularly interesting discovery, for it considerably extends the southern range of these plants. Hitherto the known limit for tree-ferns was about 47° south latitude, where, at Port Otway, in Patagonia, *Alsophila pruinata* has been met with. Both these species may be seen in some of our botanic gardens. An enumeration of the species native of the islands, with a full bibliography, concludes a most valuable treatise on insular floras.

* * *

Supra-terrestrial Vegetation.

An article is contributed by M. Virgile Brandicourt to the *Revue Scientifique* on "supra-terrestrial" vegetation, plants which grow, not on the surface of the earth, but on walls, and roofs, and trees. They form an interesting study. The oldest of them are those that grow on stone and brick walls. Sixty-seven per cent. of these are plants with fine seeds (saxifrage, arenaira, urtica. &c.), 13 per cent. plants with winged seeds, that are easily dispersed by the wind, 9 per cent. plants with fleshy fruits, 6 per cent. plants with hooked seeds, and 5 per cent. plants with an explosive mechanism for dispersing the seeds. The plants of thatched roofs are also numerous. Some of the older thatched roofs have from 15 to 16 species of plants, and the general average is eight. There is a special flora characteristic of the tops of pollard willows. As many as 86 species have been catalogued which grew thus. The most curious instance of a parasitic tree was communicated by Dr. Magnin. A mulberry tree took root on an ash, and usurped its place by pushing the ash's trunk down little by little till it was lost to sight.

METEOROLOGICAL.

Meteorological Figures.

An attempt is made by Dr. Käppen, in the German meteorological review *Das Wetter*, to express a mathematical relation between the intensity of heavy rainfall and the time which it lasts. He makes out a constant "n" for the relation, "n" being equal to the square root of the time multiplied by the intensity. By a curious coincidence the French meteorological review, *Le Temps qu'il Fait*, has an article on recorded great falls of rain, or, perhaps, we should say great "cloudbursts." On August 20, 1900, 30 mm., or well over an inch of rain, fell at Maredsous in ten minutes. The greater rate of fall recorded was, however, at Turnhout on July 10, 1899, when 25 mm., or nearly an inch, fell in six minutes, which gives a rate of 4.2 millimetres a minute. In these heavy rainfalls the distribution is very erratic. Thus, on August 27, 1902, during a storm which swept Paris, 50 mm., or not far from two inches, fell at the Parc des Buttes, Chaumont, and less than a quarter of an inch at Mont Souris.

* * *

The Velocity of the Wind.

At the Eiffel Tower, during a storm on the night of the 11th-12th of September, 1903, a rate of 42 metres a second (94 miles per hour) was recorded, but this record was eclipsed in 1894, when on the 12th of November the wind attained a velocity of 48 metres per second. America, however, cannot be beaten in such matters. On the 18th of May, 1902, a storm visited the Pacific Coast, and near San Francisco the wind was measured as travelling during several minutes at a speed of 53·6 metres a second. Since the velocity undoubtedly as a rule increases with altitude, it is not surprising to find that on the summits of high mountains still greater speeds have been recorded. M. Brunhes, the Director of the Observatory on the Puy de Dôme, claims the record wind velocity, for on the 9th of December, 1901, between 10.20 and 10.30 it blew at a mean rate of no less than 70 metres a second, or 156 miles an hour.

* * *

London Fogs.

The report of the Meteorological Council upon "an Inquiry into the Occurrence and Distribution of Fogs in the London Area, during the Winters of 1901-2 and 1902-3" has just been issued. It is, of course, past our understanding why such a report should take nearly a year to compile, but we must rest satisfied that such tardiness is not unusual with similar reports, and that doubtless there was good reason for it. During the last winter observations of the fog were recorded at 46 stations, and thermometers were supplied to thirty fire brigade stations, in order to determine the variations of temperature prevailing. Among the various supposed causes of fog, radiation from the earth's surface during calm nights is found to account for the majority. Warm air passing over previously cooled surface causes many others, while "cloud fogs" form a third class. There is no evidence to show that, in London, geological formation affects the formation of fogs, and while fogs on the river and in the open parks were frequent, it has not been found that the neighbouring districts were specially infected.

As regards forecasting the presence of fog, it is pointed out how much more valuable night observation and early morning reports would be than the present system of issuing the forecast at 6 p.m.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

Flamingoes on the Medway.

The *Field*, Dec. 24, reports the occurrence of flamingoes —presumably *Phœnicopterus roseus*—on the Medway. A young male "was recently shot on the marshes close to Gillingham," and mistaken by the shooter for some kind of goose! It is reported that another has been seen.

Although there can be no doubt that some of the recorded occurrences of this species should be cancelled as escaped birds, at least three previous instances of wild birds taken in this country must be allowed to stand. Nevertheless, so good an authority as Mr. J. E. Harting refuses to admit the Flamingo to the list of British Birds.

The Breeding of the Knot.

The *Ibis* for January contains a short but interesting account of the discovery of the hitherto unknown eggs of the Knot (*Tringa canutus*). A nest of this species, containing four eggs, was found on June 17, 1898, in the Island of Hrisey, to the north of Iceland. The bird was breeding with several pairs of *Tringa maritima*—the Purple Sandpiper—and was kept under close observation for some time before the eggs were taken. It was not killed, as the collector hoped to have the good fortune to obtain a second clutch.

The eggs are described as "quite like very large eggs of the Dunlin (*Tringa alpina*), of the closely-spotted type, and cannot be confounded with any others of the same size."

* * *

The Pacific Eider at Scarborough.

An adult male of the Pacific Eider, *Somateria V-nigra* was killed during December at Scarborough. This is the first authentic instance of the occurrence of this bird in Great Britain. Closely resembling our common Eider, *S. molissima*, it may be distinguished therefrom by the V-shaped mark on the throat, and the bright orange colour of the bill.

The Pacific Eider is found in great numbers in North-Western America and North-Eastern Asia.

* * *

Peregrine Falcon in Essex.

A fine female of this Falcon (*Falco peregrinus*) was killed at Tambridge, Essex, during the first week of January. It is a pity that these handsome and rapidly-vanishing birds cannot be protected more completely.

PHYSICAL.

More Failures with N-Ray Experiments.

MM. CHANOZ and Perrigot have been attempting to repeat an experiment made by M. Bordier, who showed that N-rays emitted by tempered steel could apparently be detected by photography. The former, however, found that equal sized pieces of steel and of lead, placed on exactly similar screens, and exposed for various periods, never gave different halos, as described by M. Bordier.

* * *

Solid Electrolytes for Accumulators.

The usual acidulated liquids employed in accumulators have many disadvantages, especially when the cells are carried in motor vehicles or in other circumstances where they may be subjected to much shaking and vibration. The liquids are liable to be spilt or to penetrate through stoppers and corrode the terminals or wires and cause other annoyances. For this reason they have sometimes been replaced by pastes or jellies.

M. Schoop, who has lately been experimenting in this line in France, gives the following preparation as one very suitable for the purpose.

1. A solution of sulphuric acid in distilled water, having a specific gravity of 1·22.

2. A solution of silicate of soda, free from chloride, in distilled water, with a density of 1·20.

3. A "bouillon" obtained by boiling for two hours in an enamelled receptacle one kilogramme of asbestos card with two litres of water acidulated with 10 per cent. of sulphuric acid. The cardboard disintegrates and is washed over a filter with distilled water, and is then squeezed as dry as possible by hand so as not to retain more than one-third its weight of water. Take 18 litres of the acid solution No. 1, add 450 grammes of the wet asbestos fibre, and thoroughly mix in a glass or ebonite vessel. Rapidly pour in 4½ litres of the solution No. 2, and stir until it assumes an oily appearance. Then pour the composition into the accumulator, the plates having been moistened with acidulated water, and leave for 24 hours to settle. The liquid gradually thickens, and finally becomes a solid jelly.

ZOOLOGICAL

By R. LYDEKKER.

The Position of the King Crab.

ACCORDING to Professor E. Ray Lankester, who has been lately discussing its affinities and systematic position, the King Crab (*Limulus*) of the Moluccas is a misnamed creature; for, in spite of its somewhat crab-like shell, it is not a crab at all, but rather a near relative of the scorpions, which are first cousins of the spiders, and are consequently included in the class *Arachnida*—a group of equal rank with the crustacea, or crabs, lobsters, &c. The extinct trilobites, which have also been classed as crustaceans, are likewise included by the same authority in the *Arachnida*, of which, however, they form a brigade of equal rank with the one comprising all the other members of the class.

* * *

The Coloration of Animals.

In a paper on coloration in mammals and birds, by Mr. J. L. Bonhote, recently published in the *Journal* of the Linnean Society, the author suggests that colour in the members of these groups is primarily due to activity of nutrition and function, or, in other words, "vigour"; and consequently that where conditions are favourable to a high state of vigour in animals, there the majority of species will be brightly coloured, and, of course, *vice versa*. Vigour he believes to be dependent on two chief causes, namely, climate (which is taken to include both temperature and food) and the rise and fall of sexual activity. In polar regions, where the two causes operate together, the changes are violent; in the tropics, on the other hand, the effect of climate is practically *nil*, and changes in colour are consequently due in the main to sexual causes. The occurrence of dark-coloured animals, like the musk-ox, in arctic climates is explained by special specific vigour. The "bleaching" of the hair of mammals and the feathers of birds is regarded as an active process, and not merely the effect of "weathering."

Natural selection and protective coloration take, in the author's opinion, a secondary position, because, although undoubtedly important factors, they are only able to make use of such colours or to modify such markings as have been produced by vigour.

* * *

Papers Read.

The most important event at the meeting of the Linnean Society, held on December 1, 1904, was a discourse by Professor S. H. Vines on proteid digestion in animals and plants. At the meeting of the same Society on December 15, Mr. C. C. Hurst communicated notes on heredity in rabbits, based on crosses between a Belgian "hare" and an albino Angora; and on January 19 Dr. W. G. Ridewood read a paper on the osteology of the skull in the bony fishes of the families *Osteoglossidæ*, *Pantodontidæ*, and *Phractolæmidæ*. At the meeting of the Zoological Society on December 13, Mr. O. Thomas exhibited skins of a gazelle from Palestine, which he regarded as indicating a new species. The important feature of the meeting was, however, the exhibition by Mr. Rothschild of a large series of mounted skins, skeletons, and skulls, illustrative of a paper on the man-like apes, in the course of which the author described the gorilla of the South Cameruns and the white-faced chimpanzi of the Gabun as new. Dr. Ridewood contributed a paper on the skulls of the herring-like fishes, Professor Minchin discussed the British sponges of the genus *Leucosolenia*, Mr. Blanford described a number of land-shells of the genus *Macrochlamys* and allied types, and a communication from Mr. M. Jacoby was read containing descriptions of beetles of the family *Hallicidæ* from South and Central America. At the meeting of the same Society held on January 17, Mr. W. F. Lanchester contributed three papers dealing with annelids and other invertebrates from the Malay Peninsula and Zanzibar; Mr. A. D. Jenner discussed the minute teeth on the palate and gullet of sharks and rays; and Mr. Beddard read one paper on the anatomy of the Australian frilled lizard (*Chlamydosaurus*) and its allies, and a second on the brain of the black ape (*Cynopithecusniger*) of Celebes.

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REVIEWS OF BOOKS.

Biochemistry of Muscle and Nerve. W. D. Halliburton, M.D., F.R.S., pp. 160; price 7s. 6d. net (London: John Murray, 1904.).—This book consists of a reprint of two courses of lectures delivered in London and the Herter lectures delivered in New York. For the material of the book we have nothing but eulogy, but the arrangement leaves something to be desired. The book is really a republication of experimental lectures, and in the book Dr. Halliburton describes experiments which he was actually performing in the lectures. The reader of the printed pages cannot, however, see the performance of the experiments, and finds it a little exasperating to read: "Let me now show you with this other freshly-killed rabbit another way of making muscle plasma. . . . The iron lemon-squeezer is very effective for the purpose. You see the drops of muscle plasma." . . . And so on. Surely it would not have taken a great deal of trouble to alter the tense when preparing the lectures for press. This is our only adverse criticism, for the rest we hardly know where to begin, the book is so interesting. The first lecture is more or less introductory, and opens with an account of the composition of the muscle. A description is given of the manner in which proteids can be separated from each other, in the first place by fractional heat coagulation. This was demonstrated before the audience in the case of muscle plasma, the first coagulation taking place between 42° and 47°, the second coagulation at 56°. Another method being that of salting out with ammonium sulphate. "Thus half saturation with ammonium sulphate (one of the most frequently employed of the neutral salts for the fractional precipitation of proteids) will precipitate globulins; complete saturation with this salt is necessary to precipitate albumins." Lecture II. deals with heat rigor. A muscle loses its irritability and contracts permanently when gradually heated to a certain temperature, this being due to the coagulation of the proteid material of the muscle. Diagrams are given showing that the contractions at different temperatures correspond to the coagulation temperatures of the various proteids. Chemists will find Lecture IV. one of the most interesting. It treats of the "extractives and salts of muscle." It should also interest athletes, because the author refers to the feeding of those in training, and explains that, although muscle works most economically when chiefly fed on proteids, during recent years feats of great endurance have been carried out by men fed mainly on carbohydrates. Most readers will probably remember the feats of marching undertaken by the German Army upon a food consisting of a few lumps of sugar or of chocolate. It appears, therefore, that a more or less mixed diet is probably the best. "Metabolism in Nervous Tissues" is the title of the seventh lecture, and is illustrated by a number of very useful diagrams. The study of the metabolic activity in nervous tissues involves the discussion of fatigue and sleep. It is interesting to note that whereas large doses of carbonic acid act upon the nerves as an anæsthetic, and therefore abolish electrical response, small quantities increase its activity. "A nerve thus forms a very delicate test object for this gas; far more delicate, in fact, than most chemical reactions are." Another point of interest is the demonstrable fact that fatigue takes place in the nerve centres and in the peripheral endings of nerve fibres, but the nerve fibres themselves appear to be non-fatiguable. The book interests us so much that we are tempted to give quotations from nearly every page. This would not be fair to the author, and the Editors of KNOWLEDGE would probably object from reasons of space. Every medical man and others who, although not having special medical training, have scientific training, should read this book. The author knows how to bring out the salient parts of his subject with incisive clearness, and the fact that so much of the work has been carried out by himself and co-workers adds very greatly to the value of the book.

Bacteriology and the Public Health. By George Newman, M.D. Third edition: John Murray.—There are so many points of contact between public interest and the science of bacteriology that a book which views the present knowledge of bacteria from the standpoint of public health has claims to consideration from every side. It is in the highest degree important that scientific men who have the ability to do so should present to the popular mind in a clear and convincing manner the bacteriological processes on which we rest our treatment of some diseases, our sanitary measures and precautions, and our scientific treatment of food stuffs. To take one example from several others in Dr. Newman's chapters, there is the question of immunity from disease. The bacteriological principle of immunity, divested of the many complexities with which Ehrlich and Welch and others have sought to clear up certain difficulties and contradictions, is briefly this: That when the blood is infected with any bacterial poison a specific antidote is detached from the blood's corpuscles to combat the poison; and that this antidote remains in the blood after the poison has been met and vanquished. Thus in order to cultivate the antidote we infect the blood with a mild dose of poison, and the blood in response prepares a quantity of antidote which will resist the onset of the poison if it should appear in large quantities. It is on this principle that we vaccinate as a preventive against smallpox; that we vaccinated with a sort of broth of typhoid bacteria, in order to preserve our soldiers in the South African war from enteric; that we prepare a serum in the veins of the horse as an antidote against diphtheria; or that we tried to find an antidote to the poison of the tubercle bacillus. Some of the processes by which immunity can be artificially secured from such treatment of the blood have been successes; some have been failures; and some, though believed by scientific authorities to have the germs of success in them, have excited profound public mistrust. In the case of one method, that of anti-typhoid vaccination, the distrust among soldiers and sailors was sufficiently manifest to make the Government abate the use of Professor Wright's vaccine, probably because they felt that its continued use might prejudice recruiting. That was a quite legitimate exercise of caution on the part of the Government; and they might also plead on behalf of their action (though Professor Wright has produced figures which strongly support his contention that the vaccine is efficacious) that bacteriologists are divided in opinion concerning the Wright vaccine. It is maintained by some that his method of sterilising the bacteria does not extract, as it were, the intra-cellular poison in efficacious proportions. But whatever may be the truth about this particular remedy, it is of the highest importance that the public should approach these new methods of treatment with understanding and without prejudice. Dr. Newman's book is not a text-book; and it does not treat this subject very fully. It rather presents conclusions than justifies them. We call attention to this particular brevity in the present edition because we should like to see it remedied in a future one, for we believe that there is hardly any question which, in the public interest, should be made more clear to them than the principles on which the bacteriological treatment of disease rests. But if in the one instance we have chosen Dr. Newman appears to err on the side of conciseness, we cannot refrain from expressing our highest admiration for the masterly digest he has made of the many subjects of the highest public importance which are bound up with bacteriology, and for the extremely able manner in which he has presented the very latest information and theories in respect of them. Among the subjects, as amply illustrated as summarised, are Bacteria in Air and Water, the Bacteriology of Sewage, Bacteria in Milk, Bacteria in Foods, Tropical Diseases, Tuberculosis Immunity, and Anti-toxins and Disinfection. The earlier chapters are a summary of bacterial biology and theory.

Birds of Russian Lapland, by Henry J. Pearson, Mr. Pearson is a most enthusiastic ornithologist, who has made the north of Europe for many seasons his hunting ground. His ardent search for the nesting places of birds has led him into many wild countries in northern regions. A few years ago some of these journeys and their results were described in "Beyond Petsora Eastward," and "Three Summers among the Birds of Russian Lapland" may be called a sequel to that volume. The work of three seasons included that of 1899, when the author visited the coast of Russian Lapland; that of 1901, when he voyaged to the Kanin Peninsula on the east side of the White Sea; and that of 1903, when the interior of Russian Lapland was visited. The book is arranged in the form of a diary; its contents will be especially valuable to those interested in the species of birds which nest in the north, many of which—such as fieldfares,

redwings, ducks, geese, and waders—are familiar visitors to England in winter. The last chapter of the book deals with history rather than natural history, and is devoted to St. Triphon, "the enlightener of the Laplanders," and the monastery founded by him on the Pechanga River in North-Western Russian Lapland. Mr. Pearson's work is profusely illustrated with reproductions of the author's beautiful photographs. There are 68 full-paged plates in all. Besides the many charming photographs of the birds and of nests and eggs, others illustrate most effectively the country and the people, and others the flora. Mr. Pearson is much to be congratulated on compiling so fine a record of his wanderings in these wild and barren, but fascinating, regions.

The Process Year Book for 1904-5 (Penrose and Co.; 4s.) comes out as a handsome volume, replete with hundreds of beautiful illustrations in all styles, of which 54 are in colour. This is the tenth year of issue, and it may well be supposed what an interesting exhibition it forms of the progress made in this art. To quote from the preface: "Ten years is a short period as history is made and measured, but it has been long enough for process workers to achieve a great deal. Few modern industries have progressed at such a rapid rate, and few have so rapidly and completely revolutionised or superseded older methods." A number of interesting articles by well-known experts in the various branches of process printing complete this valuable history.

Dyes and Stains and Polishes.—In "Dyes, Stains, Inks, Varnishes, Polishes, &c., including the art of Wood-staining, Filling, and French Polishing, Briefly, but Sufficiently and Clearly Explained" (Dawbarn and Ward), the author, Mr. Thomas Bolas, sufficiently and clearly, if not briefly, explains the contents and scope of his small sixpenny handbook. It is intended for the beginner, and it is terse and far from being overloaded with detail.

The Elements of Geometry, by Braithwaite Arnett (Simpkin, Marshall and Co.; price 2s. each part).—Geometry does not change much with the times, yet new books periodically appear to instruct us in the old science. In the three small volumes before us there is certainly some novelty. A good deal not usually included in such works is introduced. Trigonometrical ratios, comparative scales, points of the compass, even thermometer scales, are briefly but clearly gone into, and in the more minor details of bold and simple diagrams and large type a decided improvement on many older text books is effected. It almost seems a pity that more changes are not made. For instance, many definitions, which, though strictly according to custom, are in reality very useless in modern instruction. Take No. 16, "When a straight line is drawn between two given points which are its ends, it is called a finite straight line." It is *not*, in common parlance, called a "finite straight line," and if it was, that would surely be a sufficient description. So, also, it seems rather unnecessary to lay down that "a rectangle has all its angles right angles."

"The Elements of Trigonometry, by S. L. Loney (Cambridge University Press; price 3s. 6d.), may be criticized in much the same way as the foregoing. There is nothing exceptionally new in this small book, which is intended for the use of students commencing Trigonometry, but the subject is simply and clearly put, and heavy type introduced to emphasize special points.

"Stories from Natural History," by Richard Wagner. Translated from the German by G. S. (Macmillan; 1s. 6d.).—This is a most excellent little book for children, calculated to awaken their interest in animals and to encourage their powers of observation. Quite short accounts of different animals are simply given, and these are well illustrated from photographs.

How to Build a Bicycle, by Mr. R. H. S. Williams, and **How to Build a Petrol Motor,** by Mr. James F. Gill, B.Sc., are the titles of Nos. 4 and 3 of the "Home Worker's Series" (Dawbarn and Ward; 6d. net). They are simply written and practical handbooks, specially adapted for use by amateurs. **"Toning Bromide,"** by Mr. R. E. Blake Smith, is the subject of No. 16 of the "Photography Bookshelf Series" (Iliffe and Sons). The author's name is familiar to photographers through the method of sulphide toning introduced by him. This method is dealt with in the present volume, and the author gives besides detailed descriptions of other methods of modifying the colour of bromide and other developed silver prints.

Astronomy.—The appearance of a third edition of the admirable and fascinating book by Mr. Walter E. Maunder, F.R.A.S., "Astronomy Without a Telescope" (W. Thacker and Co.) is interesting, not only as a tribute to its great and well-deserved popularity, but as proving the existence of a large and increasing number of persons who take an intelligent interest in the study of natural phenomena.

Astronomy for General Readers (Whittaker and Co.), by Mr. George F. Chambers, F.R.A.S., is re-published in a cheap edition at the price of one shilling, whereby a useful and readable book is brought within the means of the general reader of popular science.

Fireside Astronomy (Witherby and Co.; price 1s. 6d. net) by Mr. D. W. Horner, F.R.Met.Soc., M.B.A.A., is intended, as its title suggests, to meet the requirements of the intelligent amateur, who, having neither the time nor the means for a serious study of the subject, would yet be very glad to know in a general way something of the science of astronomy.

Examples in Arithmetic (George Bell and Sons; with or without answers, 3s.) is compiled by Mr. Charles Pendlebury, assisted by Mr. F. G. Robinson, from his "New School Arithmetic." The examples range from elementary to advanced arithmetic, Part II. including elementary mensuration and logarithms.

"Hints on Collecting and Preserving Plants" (West, Newman, and Co.; price 1s.), by Mr. Stanley Guiton, contains useful hints for the formation of a herbarium by a young collector, and gives advice respecting the best means of collecting, drying, preserving, and arranging plants.

"The Hygiene of Bird-Keeping," by Mr. W. G. Creswell, M.D., L.R.C.P., F.Z.S. (R. G. Clement; price 1s. net), consists largely of articles which have appeared in "Bird Notes." It gives practical and sensible hints on the housing and feeding of birds.

"Christianity and Rationalism on Trial" (Watts and Co.; price 6d.) is the title of articles by various authors contributed to the *Clarion* in the course of a controversy which took place in the pages of that journal on the subject suggested by the title.

"Do We Believe" (Watts and Co.; price 6d.), by Mr. John Allan Hedderwick, summarises a correspondence which took place on the subject of "Belief" in the columns of the *Daily Telegraph*, and attempts to show what, in the author's opinion, are the foundations of a stable belief.

"Christianity and History," by the Rev. J. Neville Figgis, and **"Britain and Her American Colonies,"** by Mr. E. and S. Horsburgh (James Finch and Co.; 2s. net) are two of a series of small volumes published with an educational purpose. They are primarily intended as the subjects for essays or holiday tasks; and examination papers by the respective authors can be supplied to teachers at 5s. per 100 copies. The subjects dealt with are treated in a readable and popular style.

"Italian Varnishes."—Mr. George Fry, F.L.S., F.C.S., believes himself to have solved the long-vexed problem of the varnishes used by the great Italian masters of violin-making. The results of his study and experiment are given in his book on "The Varnishes of the Italian Violin-Makers of the Sixteenth, Seventeenth, and Eighteenth Centuries, and their Influence on Tone" (Steevens and Sons; price 6s.). Hitherto experts who have had facilities for examining the varnishes on old Italian instruments have believed it to be an oil varnish coloured according to the fancy of its individual makers, and divers explanations have been offered to account for the inability of modern violin-makers to reproduce it. Mr. Fry suggests as the explanation of the problem that the old violin-makers used as the constituents of their varnishes the natural products of trees (conifers) and plants (flax) growing in their immediate vicinity; that they were simple varnishes composed of resin and turpentine, or of these two substances and linseed oil; and that the various apparent colours were due to optical effects naturally arising from variations in the details of the preparation of the varnishes. We can only say, without seeing and hearing the results of Mr. Fry's experiments, that the arguments used by him in support of his assertion, and his descriptions of the experiments made by him, are exceedingly interesting, and worthy of attention.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Fibrous Constituents of Paper.

PAPER is generally understood to be made from "rags." This is, however, only partially true, as papers may be considered to be roughly divided into two classes: white printing and writing papers, of which only certain of the writing papers have much rags in them; and coarse wrapping and bag papers, including brown papers, which are almost entirely innocent of rags. Of late years in particular a revolution has taken place in paper-making by the use of wood-pulp. Twenty years or so ago the use of wood was limited to what is known as "mechanical wood-pulp," short broken fibres torn from logs by means of some grinding apparatus, and it was considered impossible for satisfactory fibres with good "felting" properties to be obtained from so stiff and intractable a substance as wood. Then came the introduction of chemical wood-pulp, in which the logs of wood have been treated by the soda bisulphite or sulphate processes, the result being soft white fibres which are now more largely used in paper-making than any other material.

The testing of a sheet of paper is, in England, almost entirely a question of experience. Colour, feel, hardness, absorbent properties, strength, freedom from dirt, specks, and other imperfections—all these are decided by looking at and handling the paper only, and the buyer would probably be much puzzled if it were suggested that he should make a microscopical examination of the papers he had bought. The result is that there is in England no standard of comparison by reference to which disputes as to quality may be readily settled. In Germany, on the other hand, at Charlottenburg, there is a Government laboratory for the sole purpose of testing papers, not only those used by Government departments, but any others which may be submitted. This does not necessarily show, however, that such a laboratory is needed here, for whilst a more uniform set of standards might be of service, the requirements of various papers vary so greatly that rigid, inelastic tests may easily be very misleading.

The microscopical examination of paper, however, limited, as it generally is, to the ascertaining of the fibres of which the paper is made, has no such disadvantages other than those due to the necessity for training and experience in such a matter, and it is a matter of surprise that this branch of paper-testing has not received more attention in this country. It may be of interest to many of the readers of these columns if I endeavour briefly to explain the methods of recognition of the various fibres, avoiding as far as I can all technicalities.

(To be continued.)

Royal Microscopical Society.

At a meeting held on December 21 at 20, Hanover Square, Mr. G. C. Karop in the chair, Mr. Conrady read a short paper explaining an experiment he exhibited to prove the phase-reversal in the second spectrum from a grating of broad slits, the mathematical proof of which was given in his paper on "Theories of Microscopical Vision," read before the Society at its last meeting. The object consisted of two gratings, one above the other, similar in every respect except that one had broad and the other narrow slits. In accordance with what was theoretically predicted by the author, the difference was brought out when the direct light *plus* the first and second spectra of *one side* were admitted, but when the direct light was cut off by the movement of a shutter the image of the *broad slits* underwent a startling change. The lines jumped across to positions midway between the correct ones, showing there was an antagonism of phase between the light of the first and that of the second spectrum. Some photographs were exhibited by Mr. Rheinberg which showed the effects produced by cutting out the various spectra of one side, and he suggested to Mr. Conrady that the experiment should be made to test the correctness of the theory. Mr. J. W. Gordon then gave a summary of his paper "On the Theory of Highly Magnified Images," and illustrated his remarks by numerous diagrams shown on the screen. A discussion ensued in which Messrs. Rheinberg, Beck, and Conrady took part, and Mr. Gordon briefly replied.

The Quekett Microscopical Club.

The 418th ordinary meeting of the Club was held on December 16 at 20, Hanover Square, W., the President, Dr. E. J. Spitta, V.P.R.A.S., in the chair. After the ballot had been taken for the new members, the President announced that fifty members had been elected during the past year, and congratulated the Club upon the increase, which he hoped would be fully maintained in the future.

Mr. C. G. Curties, F.R.M.S., exhibited and described the new Nernst electric lamp arranged for use with the microscope, and also one of Baker's "Diagnostic" microscopes, a model combining extreme portability with firmness.

Mr. D. J. Scourfield, F.R.M.S., gave an interesting lecture on "Fresh Water Biological Stations," illustrated by lantern views of the exterior and interior of the principal fresh water biological stations in Europe and America. He pointed out that they had their origin in the general deepening of biological research which followed the establishment of the Naples and other marine biological stations, between the years 1870-1890, aided by the rise of Limnology, which in itself was largely due to Professor F. A. Forel, who had shown by his work on Lake Geneva what might be done by a systematic study of lakes. The first fresh water biological station in England was started in 1902 at Sutton Broad, Norfolk, by Mr. Eustace Gurney, and although the station was as yet but little known, it had already been the centre of good work, and deserved every encouragement.

Improved Methods of Working with the Vertical Illuminator.

I am indebted to a correspondent for the following methods of using the vertical illuminator:—

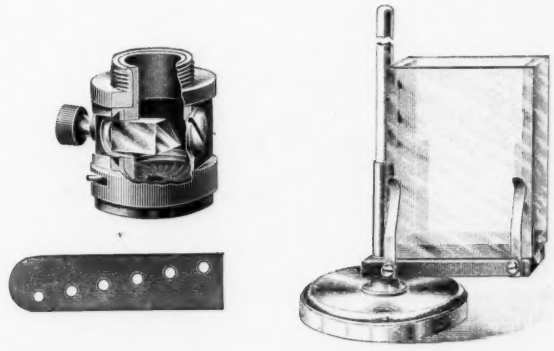
Method I.—With the image of a stop. Method II.—With the stop and the vertical illuminator.

The accessories necessary for Method I. are (1) source of light; (2) carrier for stop; (3) condenser; (4) vertical illuminator. The condenser is first set between the light and the vertical illuminator, so that it forms an aërial image of the source of light at a distance from the vertical illuminator equal to that from the vertical illuminator to the top of the eye-piece. The carrier for the stop is then placed between the light and the condenser in such a position that its aërial image is exactly adjusted and falls sharply in focus at the back lens of the objective. This will give an effect precisely the same as placing a stop or diaphragm over the vertical illuminator itself, while the upward path of the rays from the object to the eye is unimpeded.

The accessories necessary for Method II. are (1) source of light; (2) bull's-eye condenser; (3) vertical illuminator with stop or diaphragm fitted *to its side*. For this method, the lamp and bull's-eye are adjusted as in Method I., care being taken that proper distances are kept, when the same effect will be produced as with a stop or diaphragm placed immediately over the vertical illuminator.

New Vertical Illuminator and New Monochromatic Trough.

Messrs. R. and J. Beck, Ltd., have brought out a new vertical illuminator of the prism type fitted with an iris diaphragm beneath the prism for cutting off outside light, and a plate of stops so arranged that the position of the beam of light impinging on the prism can be varied until parallel light of the right angle is obtained. The vertical illuminator is largely used now to illuminate the surface of metals when making metallurgical examinations with the microscope. The principle is that a beam of light sent at right angles to the optic axis of the microscope is reflected by a prism



or piece of cover-glass down upon the object so that each objective acts as its own condenser. It is probably the only means of illuminating objects mounted dry when they are examined with immersion lenses, though in this case it is necessary that the object should be in actual contact with the cover-glass.

The trough is noticeable for its compactness and easy adjustability. It can be brought as low as one inch from the table or raised to a height of nine inches. The fluid used in the cell depends upon the required colour of the light.

Notes and Queries.

Examination of Water.

John Carrington, East London, S.A.—I do not think you would find anything in town-water unless it was very bad. Under any circumstances a Botterill's trough would not do, as the thickness of the glass and the depth of the cell would prevent your using a high enough power. I would suggest your getting a sample of water from a stagnant pond or old tub, taking up a few drops with a glass tube, and by examining it in an ordinary excavated cell, covered with a thin cover-glass, you will find enough to interest you there. The weird animal life exhibited sometimes in a drop of water at lectures has, I am afraid, been specially selected to astonish the audience.

Deane's Medium.

Mr. T. H. Russell, of Birmingham, would be glad to know if any reader of these columns has had any experience of Deane's medium for mounting vegetable specimens for the microscope. He says he has been in the habit of mounting his mosses in glycerine jelly, but, like most people who use it, has found it somewhat treacherous. He has found Deane's medium more reliable in some ways, but it has a tendency to shrivel up certain specimens—*e.g.*, some large-celled mosses—directly they are immersed in it. He tried boiling them first in a little dilute glycerine and water, also adding a little water to the medium, but without improvement. He would be glad of suggestions as to the cause of this, or a formula for making the medium other than that given in Davies' book on "Mounting Microscopic Objects." I do not think I have ever used this medium myself. Can any reader make any suggestions?

Naming Specimens.

H. W. V., Birmingham.—I am anxious to help my readers as much as possible, but I do not think you quite realise how much work is involved in naming specimens. Microscopy covers so wide a field that it is impossible for one man to have the minute specialized knowledge necessary for identifying specimens in the whole field of Nature, and I have therefore to get my friends in Cambridge and elsewhere to assist me in such matters. For instance, I would rather not name specimens of either fungi or mosses, and I hesitate to hand them over to specialists unless I am quite sure that they are more or less uncommon species which have an unusual interest to some correspondent who is working specially on them. If this be so in your case I will do what I can for you, but I trust you will forgive this public reference, because I receive so many requests to name specimens that I have thought some little explanation may be of service. On purely microscopical matters I am glad always to do what I can, however elementary the questions.

Observation of Flagellæ and Cilia.

J. W. Brown, Inverkeithing.—The ⅛-inch objective you mention is an excellent one, but flagellæ and cilia are generally most difficult to see, especially if the animal is alive. Your best plan will be to add a little cocaine to the water and watch till the movement begins to slow down, when you may be more successful. I do not think a more costly lens would be of any greater service to you, but you are not giving either yourself or your objective a fair chance if you have not got a sub-stage condenser. The improvements in modern high-power objectives are almost nullified without a condenser. Could you not extemporise a ring that would enable you to use a 2-inch or 1-inch objective as a condenser? You will find, however, that the absence of an iris diaphragm to adjust the light is yet another drawback, as cilia will not bear a large cone, being so lacking in contrast. You cannot get good dark-ground illumination with lenses of higher aperture than about ·6 N.A., in fact you will probably find any objective higher than a half-inch does not give good annular illumination. The spot must be proportioned to the aperture of the objective, the larger the angle (that is, generally, the higher the power) the bigger must be the spot.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

XUM

The Face of the Sky for February.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 7.41, and sets at 4.47; on the 28th he rises at 6.50, and sets at 5.36. The Sun is after the clock, the equation of time being approximately 14 mins. throughout the month.

For plotting the positions of spots, with respect to the axis and equator, the following table may be used:—

Date.	Axis inclined from N. point.	Equator N. of Centre of disc.
Feb. 5 ..	13° 55′ W.	6° 24′
,, 15 ..	17° 35′ W.	6° 54′
,, 25 ..	20° 40′ W.	7° 11′

THE MOON:—

Date.	Phases.	H. M.
Feb. 4 ..	● New Moon	11 6 a.m.
,, 12 ..	☽ First Quarter	4 20 p.m.
,, 19 ..	○ Full Moon	6 52 p.m.
,, 26 ..	☾ Last Quarter	10 4 a.m.
Feb. 8 ..	Apogee	7 48 p.m.
,, 20 ..	Perigee	11 36 p.m.

A partial eclipse of the Moon takes place on February 19. In this country the Moon rises about half an hour before first contact with the shadow.

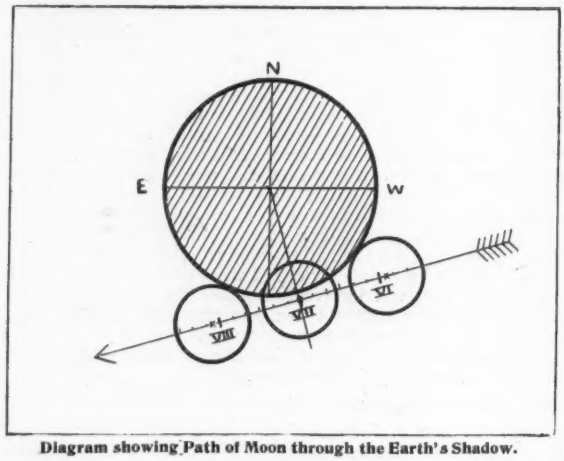


Diagram showing Path of Moon through the Earth's Shadow.

Further particulars are as follows:—

First contact with Penumbra Feb. 19 4.41 p.m.
,, ,, ,, Shadow ,, ,, 5.54 ,,
Middle of Eclipse ,, ,, 7.0 ,,
Last contact with Shadow ,, ,, 8.7 ,,
,, ,, ,, Penumbra ,, ,, 9.19 ,,

Magnitude of Eclipse 0·410 (Moon's Diam. = 1.)
Moon rises at Greenwich, 5.16 p.m.

OCCULTATIONS.—The following are the occultations of the brighter stars visible at Greenwich at convenient times.

Date.	Star's Name.	Magnitude.	Disappearance.			Reappearance.		
			Mean Time.	Angle from N. point.	Angle from Vertex.	Mean Time.	Angle from N. point.	Angle from Vertex.
			p.m.			p.m.		
Feb. 13..	62 Tauri.. ..	3·6	5.12	78°	102°	6.32	254°	259°
,, 13..	61 Tauri . ..	3·9	5.14	56°	80°	6.29	275°	280°
,, 13..	B.A.C. 1391 ..	4·9	6.48	21°	26°	7.37	311°	299°
,, 14..	111 Tauri ..	5·2	6.27	99°	118°	7.42	244°	244°
,, 21..	η Virginius ..	4·0	10.5	166°	201°	10.40	237°	269°

THE PLANETS.—Mercury is a morning star, rising about an hour before the Sun for a few days early in the month; later, he is in too close proximity with the Sun to be observable.

Venus is now the most brilliant object in the evening sky, looking S.W. The planet is at greatest elongation of 46° 41′ E. on the 14th, setting about 9.10 p.m. on the 1st and at 10.5 p.m. on the 28th. About the middle of the month the apparent diameter of the planet is 25″, whilst the phase is "half moon," 0·516 of the disc being illuminated; her lustre, however, is increasing, as the point of maximum brilliancy is not attained until near the end of next month. Throughout the month the planet souths about 3 p.m. on each day, and is easy to discern about this time even with the naked eye; the meridian altitude increases from 38° on the 1st to 51° on the 28th. The Moon is near the planet on the evening of the 8th, being 3° 20′ S. of Venus.

Mars does not rise until after midnight.

Jupiter is diminishing somewhat in brightness, and getting more to the west, and sets about 10.45 p.m. near the middle of the month; he is, however, very conveniently situated for observation in the early evening. The equatorial diameter of the planet is 37″·3 on the 13th, whilst the polar diameter is 2″·4 smaller. The satellite phenomena visible in this country are as follows:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Feb.				Feb.				Feb.			
1	II.	Tr. I.	6 50	11	III.	Sh. I.	6 42	19	II.	Sh. E.	6 28
	II.	Tr. E.	9 23		III.	Sh. E.	8 28	20	I.	Tr. I.	8 30
	II.	Sh. I.	9 26	12	I.	Oc. D.	9 22		I.	Sh. I.	9 38
3	II.	Ec. R.	6 1	13	I.	Tr. I.	6 31	21	I.	Ec. R.	9 8
4	I.	Tr. I.	10 1		I.	Sh. I.	7 42	22	I.	Sh. E.	6 19
5	I.	Oc. D.	7 23		I.	Tr. E.	8 44	24	II.	Oc. D.	9 17
	I.	Tr. E.	6 45		I.	Sh. E.	9 55	26	II.	Sh. I.	6 36
	I.	Sh. E.	7 59	14	I.	Ec. R.	7 13		II.	Tr. E.	7 2
8	II.	Tr. I.	9 35	17	II.	Oc. D.	6 29		II.	Sh. E.	9 5
10	II.	Ec. R.	8 39	18	III.	Tr. E.	8 9	28	I.	Oc. D.	7 52

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn is no longer observable, being in conjunction with the Sun on the 12th.

Uranus is unobservable.

Neptune is on the meridian about 8.45 p.m. on the 14th; he is describing a short retrograde path in Gemini, and can be found by reference to the star μ Geminorum.

	Right Ascension.	Declination.
Neptune (Feb. 14).	6h 24m 17s ..	N. 22° 19′ 18″
μ Geminorum . .	6h 17m 13s ..	N. 22° 33′ 37″

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics.
Feb. 5–10	75°	+ 41°	η Aurigæ	Slow; bright.
,, 15	236°	+ 11°	α Serpentis	Swift; streaks.
,, 20	181°	+ 34°	Cor Caroli	Swift; bright.

VARIABLE STARS.—Algol may be observed at minimum on the 5th at 9.8 p.m., 8th at 5.57 p.m., 25th at 10.51 p.m., and 28th at 7.40 p.m.

o Ceti (Mira) is due at a maximum on 25th February; its period, however, is somewhat irregular.